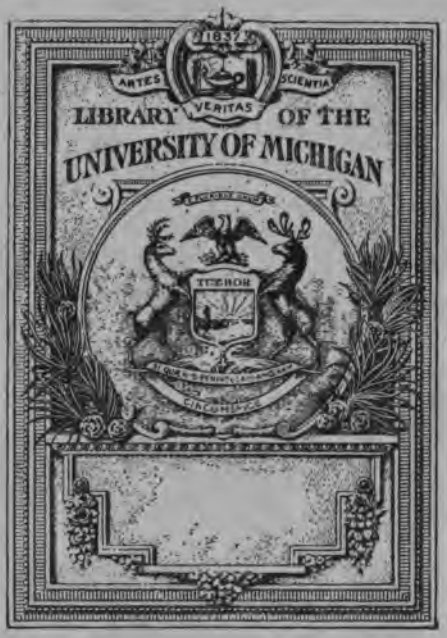
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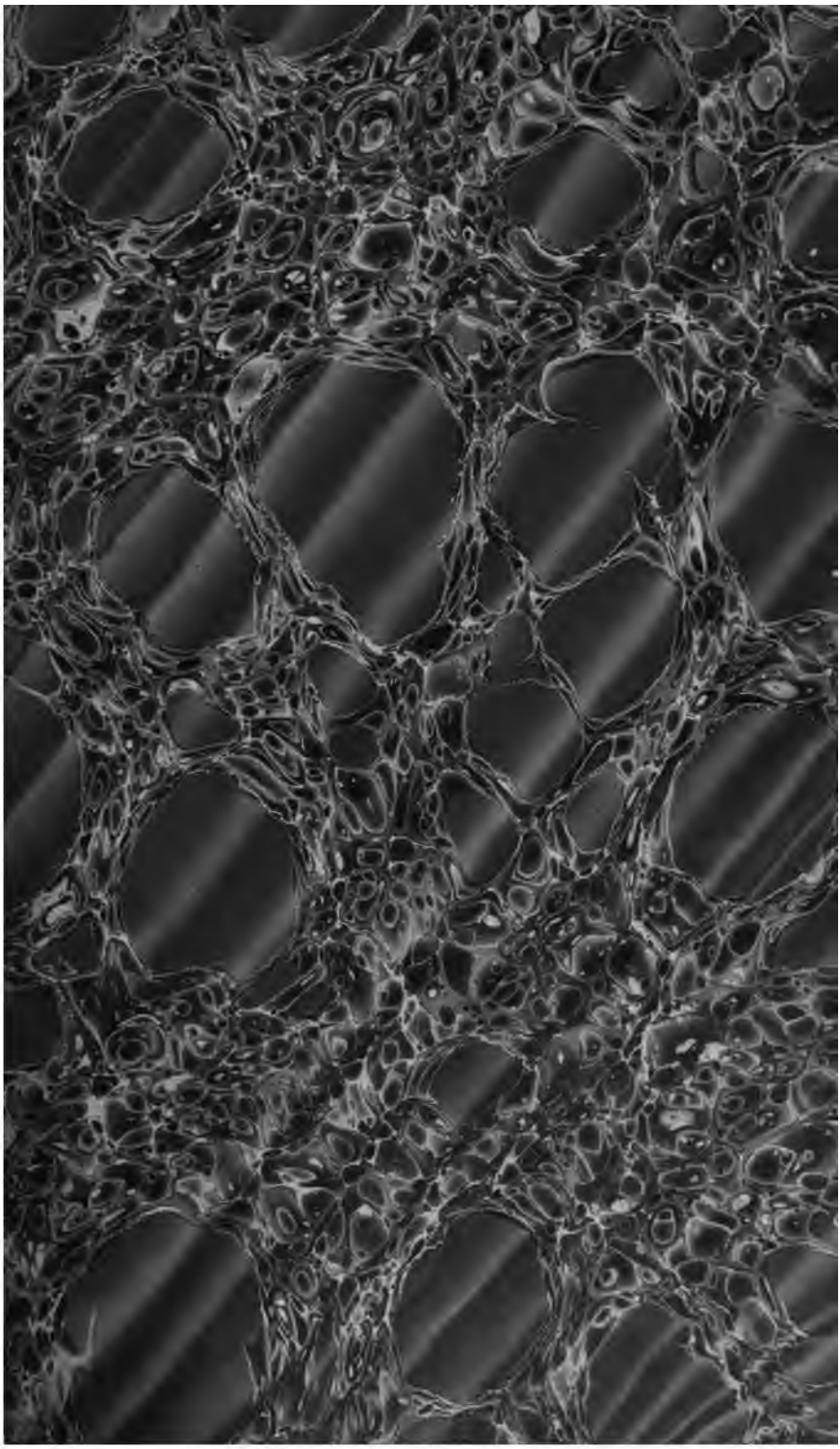

JOURNAL

OF THE

GEOLOGICAL SOCIETY

OF DUBLIN.

VOL. II.

DUBLIN:
PRINTED FOR THE SOCIETY.
MDCCCXLIII.

THE ANNUAL REPORT

OF

THE COUNCIL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN,

FOR THE YEAR ENDING FEB. 11TH, 1839.

Wheldon
Gal.
10-2-1922
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REPORT.

SINCE the last anniversary seven general meetings have been held, at which twelve communications of great interest were made to your Society. The Library and Museum have been enriched by valuable donations, of which a Catalogue is appended:—

DONATIONS TO THE SOCIETY.

The Ordnance Maps of Roscommon and Westmeath, presented by Lieut. Colonel Colby, by desire of his Excellency the Lord Lieutenant.

Four large Maps, upon rollers, of the four Quarters of the Globe, by Thomas Hutton, Esq.

Greenough's Geological Map of England, by the Geological Society of London.

Bulletin de la Societé Geologique de France, by the French Geological Society.

The Mining Review, by the Editor.

The Dublin Medical Press, by the Editors.

Ainsworth's Assyria, Babylonia, and Chaldæa, by the Author.

Michellotti's Specimen Zoophytologiæ Diluvianæ, by the Author.

A Catalogue of Fossil Fish, in the cabinets of Lord Cole and Sir Philip de Grey Egerton, by the Author.

A Collection of Fossils from the carboniferous Limestone

of Ireland, and from the chalk, colite, and silurian rocks of England, by Charles Wm Hamilton, Esq.

Specimens of Irish Lithographic Stone, Wheatstone, and Porcelain clay, by Robert Mallet, Esq.

Fossils from the Limestone of Yorkshire, by the Rev. Mr. Fisher, Rector of Kirbychrandale.

Fossils from the Crag of Norfolk, by A. Smith, Esq.

Crystals of Alum, and Sulphate of Iron, produced artificially, by Professor Johnstone, of Durham.

A very large Collection of Fossils, from the Lias, Greensand, and Muschelkalk, by Lord Cole and Sir Philip de Grey Egerton.

The Fourth Number of the Journal of the Society has been published, including all the communications made previously to November, 1838. It was published in the month of August, and your Council hope that in every succeeding year, the publication of a number of this Journal will immediately follow the close of the Session in June. Several glass cases have been added to the Museum, and the arrangement so far completed, that members may have access to some of the principal types of all the British formations.

It appears by the report from your Treasurer, that the balance in favour of the Society is £65 8s. 8d.

Your Council will now endeavour to show why they consider themselves justified in seeking from you a much more active support than they have hitherto received.

The object of your Society is threefold, embracing the establishment of geological truths, their application to the production of national wealth, and a diffusion of the pleasures and advantages which accompany the pursuits of science.

To the fulfilment of the first of these objects an Association, such as yours, is absolutely essential. Single ob-

servers, even of the simplest outward forms, cannot safely generalize from their observations, their sphere is too much confined; and those features which dwindle into comparative insignificance, when considered in connexion with the extent and variety of the formations which constitute our globe, will, in minute districts, assume a character of undue importance, and lead to erroneous conclusions. But when it is considered that almost every science must be brought to bear upon any one geological problem; and that the mathematician, chemist, botanist, and natural historian are all required to aid in the solution of it, we should not be surprised at finding it a common error for the geologist to exaggerate the importance of some one face of this many-sided study, and contract the science to the details of forms, fossils, or constituents, in following the bent of his own disposition, or the circumstances of his own locality. In a Society such as yours, each fellow-labourer throws the result of his observations into the common treasury. What is valuable is enlarged upon, what is erroneous is discarded; and distinct observations are compared and combined, so as effectively to produce an advance in the progress of science.

But it is to the second of the objects enumerated that your Council would especially call the attention of the landed proprietors of Ireland. It is to them that they must look for that support which the English proprietors have amply afforded to the "London Geological Society." Geology is not merely a speculative science; it is one upon the principles of which depends the profitable management of every portion of our island; it embraces conditions necessary to the supply of water where deficient, the drainage of it where superabundant, the construction of roads, canals, and railways, the choice of trees for planting, and of crops for cultivation. It would be easy to multiply instances where capital has been lavished in contending against nature, while

of Ireland, and from the chalk, oolite, and silurian rocks of England, by Charles Wm. Hamilton, Esq.

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her choicest gifts lay unnoticed. Our buildings have been constructed of the most perishable materials, when a little knowledge would have produced the most durable. Our wastes have continued barren, and our population in poverty, while the discovery of a single lime quarry might have fertilized the soil, and enriched the inhabitants. But when it is considered that the condition of a country depends so much upon its subsoil possessions—that the density of a population, and the mode in which it is occupied, may be traced out upon the boundaries of a geological map, and the wealth of a Birmingham or Manchester arises directly from a happy combination of geological circumstances —where science has marked the path in which industry is to tread; we ought surely to be anxious to obtain for our own country all those advantages which an accurate knowledge of rocks would carry with it. Hitherto the mineral treasures of Ireland have been sought and won principally by English capitalists; and where chance has led to the discovery of a mine upon the estate of an Irish proprietor, ignorance of geology has too often given rise to extravagant expectations, ill-directed labour, and a groundless abandonment of the enterprise. Your Society aims at ascertaining the districts in which useful minerals may possibly be discovered, obtaining records of the attempts which have been hitherto made; and by constantly laying before the public all the useful information which they may obtain, rendering the proprietor himself capable of judging of the prudence of any enterprise which may be suggested to him. To the attainment of the two first of these objects the third is subservient—the diffusion of a taste for the cultivation of the science. Of all scientific pursuits this, which is the most popular in England, has been the least fostered in Ireland; and yet it is one which has depths and shallows—interests and charms for all; from the philosopher, who discovers in the properties of matter the laws by which the universe is

governed, to the youth, whose healthy occupation is to collect the beautiful remnants of antiquity preserved in the sands of primeval oceans. But it is a science which cannot be learned from books alone; and one great obstacle to the cultivation of it which has hitherto existed in Ireland is, that there has been no collection of specimens in which a learner might see the types of the rocks which are described in books. This want your Society has endeavoured to supply; but valuable specimens have been presented to them more rapidly than their limited funds have allowed of their arranging and exhibiting to the public.

It only now remains for your Council to press upon the public the necessity of support from those whose interests they have shown to be so closely connected with the objects of the Society. The Geological Society is not one which requires a great expenditure. An outlay of about £500, and the annual subscription of 500 members, would be amply sufficient to support it in a flourishing condition. If every member would enlist four new members, the whole object would be attained.

OFFICERS OF THE SOCIETY

FOR THE YEAR 1839.

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JOURNAL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN.

VOL. II.—PART I.

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DUBLIN:

HODGES & SMITH, COLLEGE-GREEN.

M.DCCC.XXXIX.

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JOURNAL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN.

I. *Address delivered at the Eighth Annual Meeting of the Geological Society.* By JOSEPH E. PORTLOCK, F. R. S., F. G. S., M. R. I. A., Captain of Royal Engineers, and PRESIDENT of the Society.

[14th February, 1839.]

GENTLEMEN,—In rising to address you on this occasion, I cannot but reflect with regret on the little attention I have been able during the last year to bestow, as your President, on the concerns of the Society, unavoidable circumstances having almost shut out from me the possibility of attending your meetings; and I can only hope, that knowing as you do how much my time has been occupied by our common pursuits, you will acquit me of any voluntary neglect, whilst on the other hand you will feel, that the resignation of my Presidency, before the regular period of its termination, could only have tended to create still greater difficulties.

Turning, then, without further preliminary, to the great object of our meeting, I shall as briefly as possible place before you the results of the year's labours. In commencing my task, I feel much regret in noticing the total absence of any of those plain, practical papers, which, by describing the actual structure, composition, and condition of the strata, lay a solid foundation for speculation, not merely as to their own origin and modifying circumstances, but also as to the origin and subsequent phenomena of those still unconsolidated masses, which, under the name of diluvium or detritus, exercise the ingenuity of geologists.

Until, indeed, the solid strata of a country are fully known, and have been described in detail, it would be vain to attempt a separation of the native from the foreign fragments which are found in its detritus; or to strive to discover the courses of those currents, which, under any theory, must have swept over the surface of its present dry land. Often, indeed, in the minute research, which is alone fitted to fill up the finer touches of the great geological picture, portions of igneous and other rocks are seen to protrude where their existence was never suspected, and by their local insignificance and yet probable connexion with distant and more extensive masses, to shew how possible it is that they were once of greater extent, though now reduced by wear and tear to their present inferior dimensions; or if we consider these protuberances as in their original condition, their uncovered surface combines with the shattered crests, and re-entering angles of the various beds, even of the older schists, to shew how early in the history of our planet commenced the work of degradation. Look, for instance, at the junction of the older conglomerates and sandstones with the primary schists, and you will see those strata of undoubted mechanical aggregation sometimes covering the projecting edge of a stratum, sometimes penetrating into, and horizontally deposited over a deep re-entering angle of the schists, just as it were in a natural or modern bay, and you will feel that the work of destruction by wear, and of renovation by the deposition of new detritus, can be traced in the earliest records of the earth's strata. Such was the opinion of Hutton, who by no means trusted alone to the action of rivers and other local forces of small amount, as it was impossible that waters flowing on the land could have distributed the detritus over the bottom of the sea, which was an essential part of his theory, and fully explained by Playfair in his nineteenth note, where he expressly says, "currents are no doubt the great agents in diffusing the detritus of the land over the bottom of the sea," tracing, as an example, the course of the Gulf stream.

How much, indeed, is it to be regretted that the workings of that and of other marine currents are not watched by a geological eye, and the nature, in every sense of the word, of the detritus left in the form of banks carefully examined. Might I here even venture to hint to such of my brother officers as are within reach of such phenomena,—for instance, those who are stationed at Newfoundland,—how great a service they might perform for this branch of speculative geology, by either personally examining the soundings of the banks, or enlisting some intelligent captains of fishing vessels, as assistants in so doing: and in like manner, the currents of the Channel islands would be fit subjects of investigation.

By these remarks I have thought it right to preface my observations on the very interesting and detailed paper of Mr. Trimmer, already printed in our Journal, "On the Diluvial or Northern Drift of the Eastern and Western Sides of the Cambrian Chain, and on its Connexion with a similar Deposit on the Eastern Side of Ireland, at Bray, Howth, and Glenismaule." Mr. Trimmer commences his paper by explaining, that the term diluvial is used merely as a convenient designation for certain water-moved masses of detritus, which it is necessary to distinguish from river gravel, on the one hand, and from raised beaches or other marine formations of gradual accumulation, on the other, "and not as denoting the supposed effects of the Noachian deluge, or even of any partial inundation within the historic æra." How far this indefinite application of the term is consistent with Mr. Trimmer's general reasonings, and apparently favoured hypothesis, we shall hereafter see. But in the first place, let me set before you a brief abstract of his facts, premising that they are intended, partly by positive and partly by negative evidence, to establish thedistinction already mentioned between raised beaches and the more general masses of detritus. In the first part of the paper, Mr. Trimmer directs his attention to the detritus passing

east of the Cambrian chain into Worcestershire, using the term northern drift, as designating the position of the original localities of those fragments of extraneous rocks, such as granite, &c., which are found in the detritus. At and near the summit of Moel Tryfan, six or seven miles from the sea both on the side of the Menai Straits and on that of Caernarvon Bay, and at Moel Faban, on the opposite side of the valley to the Penrhyn Quarry; and in each, at an elevation exceeding 1000 feet, marine shells were found mixed with sand and gravel. And again, the flanks of the Snowdonian chain, and the lower ground between the Menai and the mountains, were covered by great accumulations of gravel, sand, and boulders, derived principally from the Snowdonian rocks, but *containing occasionally* fragments of granite, generally rounded, but *sometimes angular*, and also chalk flints, (supposed Irish,) fragments of carboniferous limestone, and marine shells identical with those now inhabiting the adjacent seas. Mr. Trimmer then mentions several inland localities, at which, either from his own observations, or from those of Messrs. Murchison and Strickland, Sir Philip Egerton and others, marine shells had been found associated with the detritus, at about an elevation of 300 feet above the sea. It is on these facts, which are few, and by no means described with that minuteness of detail which is absolutely necessary to guide us in the solution of so intricate a question, that Mr. Trimmer contends against the theory of Messrs. Murchison, Strickland, and others; but it is necessary that I should here explain what that theory is. In my Address of last year, I stated that the connexion of the formation of all heaps of gravel, sand, or clay, with the operations of one great deluge or flood, as an axiom not to be questioned, had tended greatly to limit the correct observation and conception of such phenomena. When, therefore, some of the brightest luminaries of the science, such as Sedgewick, Lyell, Murchison, and De la Bèche, sought to connect such heaps or banks with the more ancient strata,

by considering them as the last palpable results of those causes which had been from the earliest geological ages, and still are, in operation, they called into question no great truth resting on other authority than the mere observations of man, but simply ascribed to natural causes certain natural effects. The writings of Saussure, De Luc, Brongniart, and Razamovski, had rendered the fact familiar, that fragments of rock, often of vast size, had been spread over tracts of country far from their original localities ; and that in the northern countries such fragments had moved from north to south, the rocks of Scandinavia being found on the plains south of the Baltic, and those of the northern mountains of Russia more than 100 leagues, to the south. In the new world similar phenomena had been noticed ; and in our own countries also including Ireland, Mr. Bryce having, in a paper printed in our Journal, recorded Dr. M'Donnell's and his own observations on the subject: and Dr. Apjohn and Dr. Aquilla Smith having stated examples of granite pebbles, of large size, found in the detritus of the south of Ireland. The general fact, therefore, of a northern drift, which had brought to their present situations some portion of the detritic pebbles, is admitted by all, the nature of the drifting cause or force being alone disputed. At first the remarkable facts of the bone caves turned the scale in favour of a purely diluvial theory; and it may even be doubted whether the difficulties attendant on such an explanation are not due to the mistaken view of the nature of, and fancied modes of effecting, that phenomenon rather than to the phenomenon itself. If the elevation of the land be justly deemed a more philosophic mode of operation than the depression of the surface of the sea, when the object is to free that land from water, surely the depression of the land is in like manner a more rational *modus operandi* than the elevation of the sea when the object is to restore that land to its original position below the surface of the waters; and this, whether the result be called a deluge, or by any other name, is in fact the theory

of modern geology; since it can be doubted by no one who observes in coal strata the accumulations of forests, which must have been drifted from land now submerged; or who sees in the foot prints of tortoises, &c., on the horizontal beds of the new red sandstone, proof of ancient strands or sandy bays: and in the relics of Saurians, in the Lias, equally striking attestations to the former existence of muddy estuaries, and yet who sees these bays and estuaries now elevated and dry land, though covered by other strata, which are as striking evidences of the subsequent existence of deep seas, as were afforded by preceding strata of shallow waters or dry land: it can, I say, be doubted by no one who sees these palpable proofs of not one but several submergencies and elevations, that the mode of effecting the last or diluvial changes was, both by analogy and reason, likely to be similar to that of effecting the first. But when the word deluge is supposed to imply a sudden rush of water in some particular direction, acting violently but briefly, difficulties speedily arise, and it is soon seen that the forms of detritic masses, and the regular lamination and alternation of fine and coarse materials which they so often display, are scarcely reconcileable to, if not absolutely incompatible with, such a species of action, and must therefore be due to a different cause; hence the theory of marine currents,—and as a local application of it, Mr. Murchison's explanation of the remarkable fact, first pointed out by Mr. Strickland, that in Worcestershire a fluviatile gravel, or gravel containing fresh water shells and bones of land animals, is covered by a marine gravel, or gravel containing marine shells; namely, that the great marine current in that district swept through a strait which had the high lands of Wales and of England as its boundaries, whilst fluviatile currents were bringing from those banks or islands the fresh water and land relics now found in the detritus. As it is principally against this theory that Mr. Trimmer contends, I shall now, before stating his argu-

ments, refer to the facts of the second part of his paper. These are more extensive, and more detailed than those of the first part.

Granitic detritus and fragments of shells occur in clay as well as in loam, sand, and gravel, at various heights, from 20 to 200 feet, along the Dee. Along the vale of the Clwyd, and at various heights, a similar deposit occurs ; and at 200 feet above the sea, there is a remarkable mixture of marine and terrestrial remains, at Talargoet mine. This mixture occurs in sand and gravel, under twenty-six yards of clay ; the actual amount of the land contents of the mixture being, however, two bones, which are accompanied by marine shells, at a depth of sixty-three yards. In the rubbish heaps there were also fragments of shells, and a few limestone pebbles, perforated by boring molluscs, and no granite pebbles ; but in the clay or loam containing granite pebbles, and also fragments of shells, there were no bored limestone pebbles, nor did the surface of the rock below such detritus exhibit any perforations. From Abergele to the little Ormes Head, diluvial cliffs, not exceeding 100 feet in height, are nearly continuous, and afford good sections, the lower part consisting of a tough blue or brown clay, containing fragments of shells with imbedded pebbles of northern granite and of transition rocks and limestones, the last not being abundant, though limestone rock is adjacent ; the limestone pebbles are but little worn, and are not perforated by lithodomous molluscs. About a mile inland, at 200 feet, a bed of reddish clay, containing shells, occurs. The detritus of the slate regions is nearly local, though of considerable thickness.

Along the west of Anglesea, diluvium occurs in conical hills, of fine grained sandy materials deposited in layers, the coarser ingredients forming the uppermost portion, whilst the detritus of the east exhibits a rude mass,—not one of successive deposits, as on the west,—the smallest and most rolled pebbles being granites, traps, &c. Fragments of

shells also, though rarely, are found. Four sections on the Caernarvonshire shore, exhibit various modifications of alternate gravel and loam, sometimes with and sometimes without boulders, but no shells. The section of Dinas Dinlle exhibits alternations of gravel, loam, clay, and sand, some of the beds containing shells. At Clynog the blue clay, resting on and surmounted by gravel, again appears; and again in Bystell Bay, and at various other places, with more or less regularity. At the cliffs, near Rhiw Bay, the clay contains fragments of Antrim chalk, as did the gravel of Moel Tryfan. In the detritic cliffs of Criccieth and Cardigan Bay, no northern fragments occur; and our author, referring to the map, supposes the great northern drift to have been cut off from those localities, and a local drift to have swept down from the Snowdonian chain. The sections enumerated, and many others, show much irregularity in horizontal distribution, sometimes clay occurring below, sometimes confused gravel, sometimes sand; but it is difficult to decide whether these variations are real or only apparent, the sections being referred to the surface, and not to a common base line of elevation. Mr. Trimmer reasons on these data thus:—That the deposits exhibit sudden and transient action, because the rock under the detritus, when of limestone, exhibits no perforations of boring molluscs as such rocks below high water-mark now do, or in any case adhering balani. And again, because the stratification of such masses into clay, sand, gravel, &c., is not equally persistent with that of more ancient strata that such deposits are entirely distinct in origin from such strata, or from raised beaches, more especially as in the space described by Mr. Murchison, no sandy bays or flats, similar to those now existing on the shores of Anglesea, can be traced. He then speaks of submergence, and re-elevation of the land, as amongst the possible causes of the phenomena; and, whilst he admits the want of sufficient evidence, states, as the most probable

solution of the difficulties, extensive and violent oscillations of the crust of the earth, and movements in the bed of the Northern Ocean, whereby waves were thrown over the land, which augmented in force by sudden depressions and re-elevations of the land were enabled to carry along vast boulders of distant rocks, unaided (in most cases) by ice, as suggested by Mr. Lyell. Such is the theory supported by Mr. Trimmer, and it is one by no means sparing of convulsive agencies. Let me now briefly examine the objections urged against the opposing doctrine of a marine current, flowing for a considerable time, and with some degree of regularity.

1. The occurrence of balani on rocks, known to have been abandoned by the sea, is rare, although a single instance is sufficient to prove a former water level. The case of the cave of Uddevalla, whilst it proved the first position, shows too that they must not be sought for on exposed surfaces.

2. After the surface of a limestone rock has been subjected for thousands of years to the operation of percolating waters, is it probable that it should exhibit the same surface now as before such action—the presence of such marks of boring molluscs rather indicating the recent date of the phenomenon than giving a clue to the period of time during which the rocks were exposed to diluvial or other drift?

3. The persistence of stratification in the ancient rocks of aggregation, is only true in a limited sense. Any one who carefully studies sandstones, with their marles and conglomerates, will see numerous illustrations of that intercalation of limited beds of conglomerate, &c. in the sandstone, in all those wedge-shaped forms so frequent in diluvium. The persistence is of the whole, not of the parts.

4. Are not such irregular beds equally explicable, on the principle of varying currents, sometimes breaking through a mass before deposited, and filling up the gaps with detritus of a coarser character?

5. Are there not examples of similar deposits at very

various heights? and although it might be possible to explain a single gravel deposit by the agency of a single wave, is it probable that alternating strata of gravel, clay, and sand could have been deposited at high and low levels by the same moving wave?

6. The occurrence of land and marine remains together, proves, indeed, that dry land had existed, or did exist, when the marine detritus was deposited; but not that either the land remains were unmoved and still on dry land when covered by the marine detritus, or that they had been thus suddenly covered and suddenly abandoned.

Does not the condition of the stratified sand and gravel on the west of Anglesea, as compared with the rough masses on the east, show the action of water running through a strait on one side, and beating abruptly against the other?

7. The clay contains, according to Mr. Trimmer, 20 per cent. of calcareous matter. This is a large proportion, and is it probable or possible that one, or even several, great waves could have produced a deposit so highly calcareous in such a partial manner?

8. What is the meaning of the term loam? If it mean a mixture of certain earths, proceeding from the decomposition of rocks, of what does it consist? a question which may in all such cases be fairly asked, as I have no doubt that a chemical examination of soils will often lead us to a correct notion of their origin.*

9. In examining detritus, we must remember that one bed may have been deposited, and then swept in part away, and that the detritus occurring at one level is not necessarily part of that occurring at another. There may be many such successive deposits.

10. The absence of flat sandy deposits, or strands, in a

* This idea, I see, occurs also in the prospectus of the Highland Society for the March quarter; and an inquiry is there directed as to the origin of the soils, whether they proceed from near or distant rocks.

limited detritic district, does not prove that none such would be found in one more extended. Miles of rocky coast may be seen without such deposits; and as certain local conditions are now necessary for their existence, the presence of such conditions must be pointed out in the supposed ancient straits, before the absence of the results can be deemed a valid argument. Nor should it be forgotten, that such beaches, or strands, would be rapidly undermined and swept away, when occupying a higher relative level by the general elevation of the land, than the water which produced them.

Finally. Although I ascribe to Mr. Trimmer's observations the merit of much ingenuity, I by no means consider that they have removed the difficulties of the subject; and fully agreeing with him, that we have yet much to do before we can explain such vast and obscure phenomena, I would say, let us carefully examine the materials and mode of deposition of masses of gravel wherever they occur, and endeavour to ascertain, by observing their relative elevation and their position—spread round the peaks of mountains, or in their gorges, or detached in plains—whether there is anything like continuity in respective beds; and let us observe that it is necessary to know not merely the original localities of the mineral contents, but also those of the drifted fossils. The strong hinge of cyprina islandica, now a common shell, occurs as an abundant constituent in the fossiliferous clays of the north of Ireland, mixed with perfect shells of a nucula not now known on that coast, although the latter are so much more feeble and fragile than the former shell, the broken shells of the strong cyprina marking violence and removal, whilst the perfect shells of the tender nucula mark a tranquil and undisturbed deposit. The fusus bamfii, found by Mr. Trimmer in Wales, is a tolerably common shell on the Antrim coast; is it equally so in Wales? And further, when we endeavour to separate the ordinary masses of detritus from raised beaches, or from such deposits as those described by Mr. Smith and Mr.

Milne, let us inquire whether it is possible to mark, by any decided character, which of them was first in order; and if it appears that the stratified clays were the first deposited, let us ask how they could have resisted, without affording marks of violence, the gushing torrent of a mighty wave rushing over dry land, and therefore unbalanced, as are those of the ocean, by the waves around it.

I have been induced to extend these remarks beyond the limits within which I should have naturally confined them, both on account of the interesting character of Mr. Trimmer's observations and conclusions, and of the claim which they possess on our attention, as connecting, in so remarkable a manner, the detritus of Wales with the rocks of Ireland. I shall conclude them by a passing glance at the revived attempt to overturn the whole fabric of geological science, by representing not merely the loose detritus of gravel, and the calcareous clays associated with it, but all the fossiliferous stratified rocks, as the work of one cause—the Deluge—time being here as niggardly denied as violent and capricious changes are freely allowed, to its waters. Conglomerates, sandstones, marles, slates, limestones 1200 feet thick, all are supposed formed by this one convulsion, on the principle, that as one wave may deposit on a limited strand one-tenth of an inch of matter, so might an equivalent number of waves deposit a mass of thousands of feet of thickness. And then again, all that beautiful and wonderful chain of organic existences, which can be traced upwards from stratum to stratum, indicates, according to this theory, no successive dates of existence beyond what a few months might afford, each new combination of organic beings being the result of some change only of the direction of the flowing waters, each bay or mud bank contributing in turn its quota to the aggregate mass. Is this reasoning? Is it not rather a retrogression into the darker ages of the science? And can such statements benefit religion? Will they not rather tend to infuse doubt into the minds of those, who having

learned to link together as a necessary consequence certain phenomena with a certain cause, subsequently find that such connexion is untenable, and dismiss both the cause and the result as equally unfounded. Whilst geological speculations rest on independent ground, it matters little how many theories may rise and fall; but once connected with religious postulates, their ruin involves the fall of truths resting, indeed, on other evidence, but so unnecessarily and unwisely connected with them.

The next is a valuable practical paper by Dr. Apjohn, containing an analytical examination of many of the Irish dolomites, and showing, that notwithstanding the various localities (differing in circumstances as well as place) from which they had been obtained, the result was the same, namely, that each dolomite was a definite chemical compound of single atoms of carbonate of lime and carbonate of magnesia. In looking at natural phenomena, we are unavoidably led to seek for an explanation of appearances, and to connect together co-existing things, as being mutually dependent one on the other, or both consequences of the same cause. It was thus that Von Buch, on examining the country between the lakes Orta and Lugano, concluded that the trap porphyries, (melaphyres,) which pierce and are found at the bases of the granites of that neighbourhood, were the causes of the disturbance and elevation of the mountain chains. And again, when he observed the limestones of that district, on approaching the line of porphyries, splitting, as it were, into laminæ, the interstices of which were filled with rhombs of dolomite, then gradually changing form and colour, until at last they were entirely merged in a pure dolomite, he naturally assumed this change as another consequence of the disturbance which had led to the eruption of the trap porphyries—ascribing it to the proximate influence of magnesiferous gases issuing from the earth, the limits of the district exhibiting the change being

also those of the district of trap porphyry. The idea, therefore, of this supposed change, grew out of the coincident occurrence of dolomites, and the products of eruptive forces; but to have made it conclusive, it should have been shown that in all, or in most cases of such coincidences, a similar change had occurred, whilst, in the absence of such coincidences, dolomites do not occur. This is on the supposition that magnesia, either alone or in combination, might be volatilized. But, whatever probability might be conceded to Von Buch's reasonings, as regards dolomites in immediate connexion with igneous rocks, they have less weight in explaining the origin of the magnesian limestone of England, so often interstratified with sandstones, and containing fossils; or even of the extensive masses of the Alps, or of the many dolomitic beds associated with ordinary limestone. In these it is scarcely possible to conceive any other modification of original constitution (by igneous agency) than such as would result in the interchange of elementary particles, necessary to give rise to an atomic compound; and if such be the case with the stratified beds, why should we see in crystallized dolomites evidence of any other action, than that which changes an ordinary limestone into a crystallized marble. Dr. Apjohn's paper also contains the very interesting examination of some of the chalk of Antrim, which had been in contact with a trap dyke, and undergone very great alteration, the effect having apparently been the expulsion of the carbonic acid of the chalk, and a union of silica with the lime, the mineral becoming in composition a tri-silicate of lime, part of the lime being occasionally replaced by protoxide of iron or magnesia, as isomorphous substances. That this species of change often takes place, especially at the junction of flint with chalk within the influence of the igneous or heated rock, is certain, and it affords another beautiful illustration of metamorphism. A short paper, by Dr. Scouler, again brought before you the subject of dolo-

mites—Dr. Scouler advocating the theory of a metamorphic or secondary origin, the magnesia being supposed brought, by springs charged with carbonic acid and holding carbonate of magnesia in solution, in contact with deposits of carbonate of lime; the carbonate of magnesia being then deposited and the carbonate of lime dissolved, the one replacing the other. This theory Dr. Scouler considers supported by the local character of some of the dolomitic beds, and their proximity to foci of disturbance, which, as stated by Dr. Daubeny, are generally the loci of mineral springs. That such is frequently their position is undoubted, and, consequently, in such cases we may or we may not admit such an explanation; but in more extensive beds—having a certain reference to geological epochs—it is difficult to understand how any conceivable springs should have operated so complete a change, as not to have left trace of their operation in occasional patches of unchanged limestone. The carbonate of magnesia, in such cases, is not deposited in strings or specks amidst a paste of carbonate of lime. The mixture is a definite atomic compound of both carbonates, and consequently, the particles of the lime must have enjoyed a similar freedom of motion with those of the magnesia, or have been equally dissolved with them. Hence it would appear, that prior to their deposition the two earths were mixed in solution. The continued operation of springs would, as usually explained, rather tend to produce beds of carbonate of magnesia than of dolomite; but it is more probable that such operation is of a compound character, part only of the bi-carbonate of magnesia being reduced to the state of carbonate and precipitated, and an equivalent quantity of the carbonate of lime changed to bi-carbonate and dissolved; the spring or other aqueous solvent not only removing the superfluous carbonate of lime (as suggested by Dr. Apjohn) from an indefinite mixture of the two carbonates, but also carrying along with it and depositing, on

flowing into the ocean or general recipient, the combined carbonates, or dolomite. When, indeed, it is considered that lime and magnesia have both been derived from the decomposition of the original crust of the earth, it is natural to look for both in sedimentary deposits, more especially as the presence in sea-water (as one of its principal saline constituents) of muriate of magnesia, shews that such decomposition commenced at a very early epoch. The comparative paucity of carbonate of magnesia in such deposits being doubtless due to the circumstance, that it does not enter into the testaceous coverings of molluscous animals. The coincident occurrence of protoxide of iron, and of protoxide of manganese in dolomites, seems to require no other explanation than the similarity of the relations to carbonic acid of those metallic oxides and of the earths with which they are combined as isomorphous substances; whilst the action of heated igneous rocks may have contributed to the deposition of the dolimitic compound, both by facilitating the escape of carbonic acid, and by diminishing the solvent power of the containing fluid. I need scarcely add, that the original separation of such large quantities of lime and magnesia from the primary constituents of the earth's surface, and the neutralization of the acids which doubtless contributed to such separation, are subjects of great interest, as combining, with other facts, to shew that there was a period when the earth and its surrounding ocean were not prepared for the support of animal life.

Mr. Trimmer's second paper was our next communication. It describes the alterations of a conglomerate of the poikilitic series effected by its contact with a mass of trap, part of a dyke on the coast of Anglesea. The conglomerate is highly felspathic and fusible. The trap appears in thin strings, the masses of conglomerate involved between them being hardened, whilst newly formed crystals of felspar occur in many instances lining the cavities or hollows. The

more argillaceous strata exhibit, according to the varying fusibility of their composition, every possible gradation of change, in some cases none being visible, whilst in others it has proceeded so far that a perfect basalt containing zeolites is the ultimate result.

Such is the substance of the descriptive part of Mr. Trimmer's paper, and although I would remark, that, in estimating the amount of change effected by the intrusion of igneous rocks amongst sedimentary strata, it requires very great caution to draw correctly the line between the igneous or acting rock, and the altered or rock acted upon, I think Mr. Trimmer has added an interesting and valuable, as being detailed, example of the changes in sedimentary deposits, proceeding from their contact with highly heated bodies. The application of these phenomena, in explaining the crystalline structure of many of the schists of the Cambrian and silurian systems, possesses, of course, little novelty, as the effects of dykes and veins have already been appealed to as illustrations by not only the advocates of the metamorphic theory, but by the first founders of a well regulated Plutonic system.

The effects, indeed, produced by granite veins on the rocks they traverse, as well as by trap, as in the well known instance of the Portrush rock, (a shale of the lias changed to a species of Lydian stone,) were amongst the more powerful arguments of Playfair, in his illustrations of Hutton. There is, however, a difference in the mode of their application. Hutton considered these changes as so many examples of the effect of great heat, and he used them, therefore, as proofs of the fused or heated condition of the rock which had produced the change. The cause of such condition of the igneous rock itself he sought in the great store of internal heat still existing under the cooled crust of the globe. All crystalline rocks, those stratified, as gneiss, mica slate, &c., and those unstratified, as granite, &c., having under-

gone the action of this heat, either primarily, by contact with some portion of the original mass of the globe, or secondarily, by contact with rocks which had been reduced to their heated, fused, or highly altered condition, by such contact. It is only when thus generalized, that the phenomena of dykes afford an explanation of the crystalline structure of many of the schistose or sedimentary strata. They shew the local changes effected by heat, and it is therefore assumed that heat has worked similar changes in stratified rocks; but not heat due to small dykes of melted matter, strata extending over spaces of many miles extent requiring more powerful agencies, and shewing that the effect of internal heat must, at the period of their change, have extended even to them.

M. Boussingault, in his experiments on the mean temperature of the Torrid Zone at the level of the sea, has shewn, that in the volcanic districts of South America the temperature of the soil is unaffected by proximity to the volcanoes, and hence that their focus of heat must be at a very considerable depth: whilst M. Cordier estimates the depth at which the earth's heat would be found sufficient to melt the stony constituents of our rocks, as varying from twenty-three to fifty-five leagues. The great and simultaneous extension of earthquakes, and of volcanic action, requires such a depth in the moving force; and it would almost seem that the similar extension of many of the crystalline stratified rocks requires a cause of equal magnitude and extent. Dykes and veins, therefore, are the evidences of much greater sources of heat, and not themselves the efficient agents of more than local alterations. Even with this view, great difficulties still remain, for, taking as an example the mica schist formation, including gneiss, quartz, slate, &c., there are so many alternations of hard with soft beds, that it can by no means be inferred that the most hardened beds are always nearest to the source of heat; hence it would

appear, as I urged in my last Address, that composition has an important influence on the results, some of the strata resisting, in consequence, the influence of heat, or assuming under it very different appearances, and also, that some other agent has cooperated with heat, in producing these phenomena.

The Society at its next meeting was occupied principally with a discussion arising out of the presentation of some large artificial crystals of sulphate of copper and of alum, by Professor Johnson, of Durham. The subject of alum, as embracing a most interesting family of mineral compounds, I have already discussed in my former Address; and the general theory of the production of common alum, whether by the decomposition of the iron pyrites contained in schists or aluminous earths, and the consequent formation, first, of sulphuric acid, and then of sulphate of alumina, sulphate of potash being subsequently added; or by heating alum stone, such as that of Tolfa, in which all the elements of the compound are present; or by the direct action in volcanic countries of sulphurous acid vapours on felspathic or trachitic rocks, as occurs at the Solfatara, near Naples, is too well known to require any lengthened comment. I shall, therefore, limit my remarks to the concluding communication of Mr. Mallet.

In this, Mr. Mallet refers to the great quantities of soluble salts of iron and copper which are daily raised from our coal pits and mines, and spread through the agency of streams, rivers, and the ocean, over a large extent of surface. These salts, coming into contact with decaying animal and vegetable substances, lose their oxygen, and are reduced to sulphurets, which may again in future ages give rise to new alums and sulphates: and on the same principle, the pyrites disseminated in the coal formation may have been formed by the infiltration of solutions of these salts through the coal strata, their contact with decaying vegetable and animal

matter contained in these strata causing their subsequent decomposition.

In considering these remarks of Mr. Mallet, I must repeat a previous observation, that we ought never to overlook the difference between similarity and identity of action. The mineral solutions poured out from our mines must, doubtless, undergo the same changes, by decomposition, &c., as occur to natural solutions of the same kind, under similar circumstances; but the amount, though great, of the salts thus discharged is too small to enter into comparison with natural deposits. In many of the more ancient schists, even mica-schist, sulphuret of iron is often so abundantly disseminated as to appear a constituent of the rock, being in such cases always crystallized. If, therefore, the pyrites found in such situations proceeded from decomposition, by contact with organic matter, of sulphates filtering through those ancient deposits prior to their consolidation, the crystalline and isolated form of the pyrites must be considered one of the consequences of the metamorphic action of heat: and further, as such pyritous strata are widely diffused over the earth's surface, the cause of their production must have been equally extensive, and is probably to be found in the primary action of sulphurous acid vapours, such as those still noted in volcanic countries. In the general theory of the formation of iron pyrites, by the contact of a solution of sulphate of iron with vegetable and animal matter, Mr. Mallet has been anticipated by Professor Mitscherlich, who gives as an example the same case of water charged with such salts flowing from our mines into a lake, in which wood coal might at the time be forming.

In noticing the next communication by Mr. Dowling, on the Euomphalus, I shall for a moment pause, to express my gratification that the study of Irish fossils is beginning to attract the attention of our home inquirers, as it may be fairly said, that little has yet been done to apply them fully

and conclusively, as evidence of successive epochs, to the illustration of Irish geology. Mr. Dowling, by numerous sections, had come to the conclusion, that the euomphalus was a chambered shell; but it is only necessary that I should recall the labours of our fellow-member—the Rev. Sidney Smith—who, in 1835, discovered, also by sections, the apparently chambered structure of the termination of the spire, but on subsequent examination failed to discover any siphuncle or tube of communication between the chambers, to convince our intelligent contributor that this is a case, such as happens in the shells of other gasteropodous or trachelipodous molluscs, the animal, as it grows, withdrawing itself from the extremity of the spire, and forming a new basement or partition. In most such cases the extremity is subsequently broken off; but the depressed character of the spire of the euomphalus secures it from such an accident.

A short account of lead mines in the county of Clare, by Mr. P. M. Taylor, was accompanied by the remarks of Mr. John Taylor. The veins of calcareous spar, which contain the lead ore, run generally from the north-east to the south-west, and are as remarkable for their great width, being in places from twenty to thirty feet wide, as the ore is for its richness—having yielded from seventy-five to seventy-seven per cent. of lead, and from fifteen to no less than 120 ounces of silver per ton of the metal—and for its accumulation at the points of junction of the main with cross veins, at one of which the bunch of ore was from sixteen to twenty feet wide. One of the mines,—"The Milltown Mine,"—appears to have been very anciently worked, as rude wooden shovels and ponderous picks were found in the old workings, and marks of the fires which had been used to crack by heat the calcareous spar, in order to detach the more readily the ore, were yet visible. This mine has been abandoned, but in two others steam-engines have been

erected, and the workings are carrying on with profit. Between the Autumn of 1834 and Spring of 1838, 2500 tons were shipped from Ballyhickey mine alone; but, although at present prosperous, it is yet to be seen whether the metalliferous deposits of a limestone district, which exhibits so few marks of disturbance, will prove permanently productive. I trust the example of Mr. Taylor will be followed by Mr. Purdy and others, and that future numbers of our Journal will be enriched by records of the other mines of our island.

We had next a paper from Mr. Bryce, on a Bed of Columnar Trap, interstratified with beds of the red sandstone formation at the eastern base of Divis, where it has been infused amongst the marls or shales of this formation, in the same manner as the greenstone at Portrush, amongst the shales of the lias. The whole mass of the trap is not of similar structure, the centre alone being truly columnar, whilst the upper and lower portions are either amorphous or concretionary, spherical lumps occurring in some parts, whilst in others the columnar and spheroidal structures are blended together. Mr. Bryce further illustrated his paper by examples taken from other parts of Antrim, and adduced one in which the columns were formed of spheroids, a passage being traceable from the one to the other form of structure. The marls are much indurated by contact with the trap, which seems to have flowed from the north. Mr. Bryce brought forward the experiments of Watt, as bearing on the theory of columnar formation; but these are too well known to require further comment. On the question of the time of the eruptions of the basalt, and other trap rocks of the North of Ireland, much uncertainty still prevails. That the great mass of the trap rocks is composed of a number of successive beds or flows, separated often by considerable intervals of time, can, I believe, be fully demonstrated, as will be seen in the Ordnance Memoir; and that many of

these beds have been erupted since the deposition of the chalk, is equally certain from their overlying position; but it is by no means demonstrated, that no such eruptions occurred prior to the deposition of the chalk. In my former Address I pointed out some appearances which were in favour of certain flows having taken place during the deposition of the sandstone of Strabo; and other instances might be quoted, in which the general line of the stratification is suddenly changed on approaching a bed of trap, the beds conforming to the direction of the traversing trap, though almost at right angles to their ordinary direction—an effect which could scarcely have been produced on previously indurated strata, the trap bed, in some of these cases, attaining the level only of the beds it traverses or is mingled with. It is, therefore, very probable that eruptions of basalt occurred during the deposition of the coal grits, new red sandstone, lias, and subsequently to that of the chalk, the latter, however, having been of vastly greater extent and importance. The business of the Session closed by a paper from myself, in which I brought before the Society the experiments of M. Henry Braconnot, by which he considered he had discovered traces of organic existences in the most ancient rocks of the globe, and established a mode of distinguishing between traps, such as primary greenstones, &c. and rocks of distinctly eruptive origin, such as basalts. M. Braconnot, for this purpose, adopted dry distillation in glass tubes or retorts of the rock in powder; and whilst from the eurites of the Vosges, various primary greenstones or traps, and granites, he obtained evidence by an alkaline reaction of the presence of ammonia, he could discover no such indications in the basalt of Clermont in Auvergne; whence he concludes, that in rocks which have undergone volcanic fusion, all traces of animal matter are effaced. In this mode of research M. Braconnot is not original, M. Bonis of Perpignan having, in 1826, by similar tests, recognized the

existence of ammonia in gypsums mixed with various clays, in steatitic minerals of the primary formation, and in all rocks, whatever might be their geological age, yielding an argillaceous odour, which odour M. Bonis, therefore, ascribed to the presence of ammonia. M. Chevallier had even previously shown the presence of ammonia in native oxides of iron; and in 1829 his experiments were confirmed by M. Boussingault, who found that some iron ore from the mine of Coimba, near Marmato, when treated by dry distillation with quick lime, gave evidence of the presence of ammonia, not merely by an alkaline reaction, but also by a very decided ammoniacal odour; and to these might be added the experiments of Mr. Knox on the Newry pitchstone. Professor Mitscherlich also refers to such indications of the presence of nitrogen in mineral compounds in his remarks on the formation of natural nitrates, and states, that fossiliferous rocks give marked signs by this species of proof of their former animal character. The subject, therefore, is not new, nor is it free, as in the case of iron ore, from difficulty, yet it is one of great interest, and although probably inadequate to the object proposed by M. Braconnot, as many even of the eruptive traps must have been exposed to too great a pressure to permit the escape of gases, it may still be used as an additional argument in favour of the former existence of organic beings, even in the older and crystalline rocks. The elevated organization of the first recognized fossils, in order of time, belonging in the mollusca to the order brachiopoda and in the crustacea to the remarkable family of trilobites—has indeed always appeared a powerful argument against the progressive formation of animals, yet it ought to be equally powerful in inducing a belief that other and less perfect forms must at least have co-existed with them. We have therefore in such partial relics positive proofs that large masses of organic beings had in those early periods left no trace behind them of their existence,

and strong presumptive evidence that in those remaining we do not see the first animals of the creation.

Having now set before you, as briefly as possible, the subjects of our last year's labours—which in interest have not fallen short of those of preceding years—I shall for a moment draw your attention to works, which, though not designed for or published by our Society, are yet so valuable to us, and to Irish geology, as to deserve our notice and commendation. The first of these is the Geological Map of Ireland, by my friend Mr. Griffith your President elect; and when we reflect on the vast labour of collecting together the scattered fragments of the geological inquiries of preceding writers, such as those of Messrs. Weaver, Nimmo, Bald, Berger, Conybeare, Buckland, Bryce, &c., and of cementing them together by the results of his own personal researches, extending over years, we shall be prepared to estimate at the highest the magnitude and the merits of so important a work, and to make candid allowance for any minor defects from which it would scarcely have been possible to secure it. Time, and the labours of other geologists, will doubtless add to and amend much of the minuter details of the Map; but Mr. Griffith will still be gratefully remembered as having first drawn together sufficient materials for a task of no ordinary difficulty, that of sketching the outlines of the geology of Ireland. Time will not permit me to enter on a detailed examination of the Map; but I think it right to notice a few points which are original in Mr. Griffith's arrangement of the strata. Referring, first, to the older sedimentary rocks, we find a large tract in the south of Ireland, coloured as "Old Conglomerate, with purple and other coloured slates," and distinguished by colour from the clay and greywacke slates. In judging of this separation, it is necessary to bear in mind, that the whole of the schistose region, marked as "Clay and Greywacke Slates," exhibits in structure a great range of variety; some

strata approaching to fine slates, others having a coarse, gritty composition, and others again being similar to quartz rock, or even to flinty slate. What, then, constitutes the difference between these schists, and the slates associated with the conglomerate? The rocks of the county of Down have always been considered the lower portion of the grey-wacke system, being a prolongation of the similar rocks of Scotland; they, therefore, in all probability, belong to the Cambrian system. As yet, fossils are wanting in the decision of the question, though their possible existence may be assumed from at least one example. The schistose rocks of part of the south of Cork are in like manner appended to this section—an arrangement which, from similarity of structure, cleavage, &c. is, I believe, quite correct; but the question still remains, What separates these schists from the system embracing the conglomerate? The latter is assumed as the upper member of the whole; but may it not be possible, in following a line from Killarney by Kenmare to the sea, to determine whether the schists, which at Carran Thual dip to the south, are again reflected upwards, so as to constitute the capping member of a similar set of strata more to the south; or whether they pass under the more southern strata. I should not have dwelt so much on this matter, had not our Secretary, Mr. Hamilton, advanced another view of the subject, (in his Paper already published in our Journal,) by representing Carran Thual—the highest mountain in Ireland, and remarkable for the sharpness of its crest or summit—and Cahir-Con Rè, to its north—equally remarkable for its flattened summit, as both belonging to the same formation,—"the old red sandstone and conglomerate," a view which, I understand, Mr. Griffith is inclined to adopt. Looking at the question generally, I think it very probable that old red sandstone may be found in some of the valleys of the ridge of Carran Thual; and that other portions of the old red sandstone may have been included

in the purple conglomerate by the too great extension of the latter; but I must at the same time express a hope, that Mr. Griffith will not adopt a change removing from the greywacke system the whole of the mountains of that part of Kerry, without a renewed and close examination of the district, more especially as there is so marked a difference in the physical characters of the two districts thus joined together[a]. I would suggest also a similar examination of the southern boundary of the purple conglomerate and slate district, as it is very probable that the old red sandstone ought there to encroach upon it.

The next division of importance proposed by Mr. Griffith, is that of the yellow sandstone, as separated from the old red sandstone, and considered to alternate with the carboniferous limestone. This I also think not free from difficulty, as the carboniferous limestone is not universal; and it may, therefore, happen that such alternation takes place at one point of the old sandstone and not at another, (from the absence of the limestone,) the same stratum being in consequence sometimes called old red, and at others yellow sandstone. And, further; when alternation really takes place, of sandstones with limestones which can be shown to belong to the carboniferous limestone, ought not such strata to be classed, as by Professor Phillips, with the lower portion of the carboniferous system? whilst the presence of impure beds of limestone, containing either no fossils, or fossils not characteristic of the carboniferous limestone, would not,

[a] Mr. Murchison quotes Mr. Hamilton's Paper as authority for referring these rocks to the old red system, or Devonian system of that author: "In support of this view, we may add, that Mr. C. W. Hamilton has called our attention to a paper read by him before the Geological Society of Dublin in 1837, in which he described the rocks hitherto called grauwacke slate, which occupies a great extent in the county of Cork, as lying conformably upon the old red sandstone and conglomerate of the Gaulty mountains, and the Reeks in Kerry, and supporting the carboniferous limestone into which it gradually passes."

I think, be sufficient to warrant the removal of such sandstones from the old red sandstone. The carboniferous limestone Mr. Griffith forms into three sections; the lower limestone, including the black limestones of Galway, Mayo, &c.; the calp, or shale series; and the upper, or splintery limestone. These, he justly says, it is under some circumstances difficult to discriminate; and, indeed, until the fossils of this great formation have been studied in more detail, and with more reference to individuality of beds in their respective localities, it cannot be fairly said that the number, or comparative value, as compared with British geology, of its several subdivisions, has been fully ascertained. I shall here close my remarks on this highly important work. The doubts or difficulties I have expressed refer only to minute points, which in no degree affect the Map as a guide to the practical geologist, and were almost inseparable from the first effort to reduce to order such a large extent of geological information. To render the Map still more accurate, it will be the pride and pleasure of every member of our Society to co-operate with its respected Author.

The next work I shall notice is that of Mr. Murchison, which, though more especially devoted to the investigation of a portion of English geology, will be found equally applicable to the study of the older sedimentary deposits in Ireland as well as in other countries. From what I have already said, in referring to Mr. Griffith's Map, it may be inferred that the greywacke—or transition strata of former geologists—occupy a large portion of the surface of Ireland; and it is on this dark and uncertain ground that Mr. Murchison, commencing with the old red sandstone, has endeavoured to throw a clear and guiding light. We may, therefore, adopt his work as a clue to the examination of our own strata, with a fair hope, as has already been shown in the Ordnance Memoir, of finding amongst them at least some portion of the silurian rocks. The Tyrone strata are a striking proof

both of the existence of such rocks, and of the value of Mr. Murchison's work in their elucidation. Having been favoured with a copy of the work in sheets, prior to its general publication, I can state some instances of remarkable identity in fossils. The genus trinucleus, cryptolithus of Green, a genus of the great family of trilobites hitherto only found in well recognized transition strata, abounds here as in England, including the three best marked species, if not all the species, named by Mr. Murchison; and I am inclined also to believe, that some species of other genera are also identical, including the calymene blumenbachii. Graptolites are abundant in a stratum distinct from those containing the other fossils; and there are traces, more or less strong, of agreement amongst the brachiopoda, as, for example, in the genus orthis, as well as in other classes and orders—an arca, if such be really the genus, very similar to that described by Mr. Murchison, occurring in tolerable abundance, whilst a turritella, strongly resembling the one described in the old red sandstone system, supports here, as in England, a blending of the fossils of that formation with those of the upper silurian. One remarkable fact, however, is the apparent coexistence, in this very limited district of silurian rocks, of many of the fossils mixed together, which in England are distributed over several subdivisions of the system; though a subdivision may even here be effected. I hope soon to find that the schists of Waterford will supply another example of these rocks, and that the work of Mr. Murchison will prove there, as in Tyrone, a most valuable guide. He has, indeed, like Professor Phillips in respect to the mountain limestone, mastered not so much a district as a subject, and hence his work is not merely locally but generally useful.

Let me terminate these remarks on labours not undertaken expressly for the Society, by briefly referring to the recent researches of our distinguished member, Mr. R. Ball, on the crania of two species of ruminants found in the

bogs of Ireland. One of these belongs to a large species of ox, which Mr. Ball is inclined to consider distinct from any living species of wild cattle; and the other, remarkable for the shortness and delicacy of its horns, he also considers an extinct species, though closely allied to the Zebu or small Indian cattle. This latter resemblance I have frequently noticed in the horns; the skull I have never seen. As Mr. Ball's Paper is about to be published by the Royal Irish Academy, his facts and reasonings will be very soon beforé the public, and, as he remarks, will add other examples of the peculiarities of the Irish local fauna, already so remarkable in the cases of its hare and rat.

The remarks which I have made on the papers or subjects which have come before us, have been partly directed to the facts they describe, and partly to the deductions drawn by the authors from those facts; for in geology, as in botany and every other natural science, observation must precede theory—the statistics of each science requiring to be first established, before any reasonable hope can be indulged of unravelling the laws according to which the various phenomena are linked together, as cause and effect. The first business, therefore, of the geologist, as of the botanist, is to examine, collect, and compare; his next, to combine together and reason upon his facts; and though the latter division of the subject is the more favoured—the mind delighting more in speculation than in a toilsome inquiry after truth—I can assure the younger members of our Society, that they need not shrink back from the path of labour, as in this science it is full of novelty, and affords at every step some glance at the rich prospects which in the end will reward perseverance. Each branch of our inquiry has, too, contributed to the elucidation of some one or more of the important truths of physical and natural science. The phenomena of granite veins and trap dykes, and those of hot springs, &c., have confirmed the doctrine of central

heat, and of the original fluid condition of our planet; whilst the discoveries in fossil zoology have supplied many of the deficient links in the chain of organic existences. I will not dwell further on these almost absorbing subjects; but allow me for a moment to resume a subject of investigation suggested in my last year's Address. The link between the minor effects of heat, as shown by the alteration of rocks in contact with granite veins and trap dykes, and its vastly greater effects as displayed in the masses of igneous rocks which have been formed at so many geological epochs, is supplied by the visible effects of volcanic action; but a similar link between the minor and the greater effects of aqueous degradation is not so easily discovered; and I have, therefore, suggested an inquiry into the condition of some other planetary body, which, not having undergone wear by such causes, would at least afford an example by which the original condition of the surface of the earth might be tested. The moon is that body; and I am, therefore, gratified to record here the observations of my friend, the Rev. Dr. Robinson, as conveyed in the following letter:—

"Feb. 7, 1839. Observatory, Armagh.

"My dear Sir,

"My general notion is that you are quite right in referring to the moon as evidence of the absence of *weathering*. The sharpness of its rocks and peaks is quite surprising; for every angle and edge stick out with a ruggedness that is, perhaps, the thing which first strikes an observer with a sense of the wide difference between that globe and the earth. It alone would show that air and water are absent, had we no other evidence. But you are, I think, in error, when you infer from the great height of lunar mountains, the probable *quantity* of the wearing down which our earthly peaks have suffered. The moon has less attractive force than belongs to our planet, so that the same elevating force would do about twenty times as much work;

and there is every reason to believe that the elevating forces were far more energetic. Indeed, I regard the appearance of the moon as strong presumption against Mr. Lyell's notion, that the energy of volcanic action is as powerful now as it was in the primeval epochs of our planet. No volcanic action is now at work in the moon; but we see that it was once raging with uncontrollable fury, and on the most prodigious scale. *There* it has actually worn itself out; here, I think, we may assume that it has merely expended most of its force.

"I may here tell you some of the matter which I see, or think I see, on the surface of our satellite. The mountains of earthly shape are some pretty high, the highest peak of the said Appenines being, according to the best authority, something under 17,000 feet above the plains from which it rises; but this is a rare instance, and very few reach 6,000. They are of astonishing steepness. But the Ring mountains, or craters, are much stranger affairs. Take, for instance, Tycho, that bright spot in the south-east quarter, from which the rays seem to run. It is fifty miles in diameter, and 16000 feet deep, surrounded by broad terraces within, and with a central mountain, about 5000 feet high.

This is a type of the principal part of the lunar mountains; some are 200 miles diameter, and one nearly of this latter size 22,000 feet deep. What a paroxysm it must have been that hollowed out this monstrous crater! Observe that *all* these craters are depressed below the lunar surface, the elevation of their walls above it being in general but half their depth below it; and the question is, what became of the immense quantity of materials that must have been blown out of them. Schroeter thought that the walls, if demolished,

would fill the cavities; but this (in Tycho, for instance) is certainly not always the case, and we do not recognize heaps of debris in the vicinity. But we do find a curious appearance sometimes,—those rays to which I have already alluded as diverging from particular craters. They are peculiarly bright, but not at all elevated above the lunar surface, and give the idea of a fluid which had run out in currents, and produced some chemical change in the soil over which it passed. As these rays are themselves bristled with craters, these latter must have been of subsequent formation. The long lines terminating in those dusky places, which we sometimes hear called seas, have perchance been rivers; but as they generally seem to originate in some *crater*, they were more probably the track of volcanic fluids, which, however, must have been quite different from our lavas, and, perhaps, have played some part in the absorption of the lunar atmosphere, and the removal of its seas. In general the large craters are far more brilliant than the other parts of the moon, and the comparative obscurity of the *seas* arises from the scarcity of volcanic action there. On earth, I believe, our present volcanic products are but little reflective; it is otherwise there; but it may be remarked, that the small craters, which subsequently broke out on the greater and older ones, are much less bright, as if the expiring action had been more analogous to that of our own planet. But this at least is clear, that since the invention of the telescope the moon has been undisturbed. But I must stop by assuring you that I am yours sincerely,

"T. R. Robinson."

The very interesting observations and remarks of Dr. Robinson will, doubtless, recall to memory the trachytic lavas, and also the fact, that all lavas acquire their dark hue after exposure to the action of atmospheric causes. But I shall here pause. Enough has been said to show, that in

no science is there a more powerful combination of objects worthy of the deepest research; and I would only urge that it should be cultivated in the true spirit of philosophy. The astronomer, the chemist, the zoologist, or the botanist, seeks for no other aid, in advocating or setting forth his discoveries, than that afforded by the interest which must ever attend on the development of the mysteries of nature. Let the geologist pursue the same course, seeking truth with ardour, and setting it forth with simplicity, and he will find the votary of every collateral science stepping forward to assist in throwing light on that vast and intricate branch of human research, which involves in its speculations the laws which affect all organic and inorganic matter.

J. E. PORTLOCK.

NOTE.—The accidental delay in the publication of this Address enables me to state, in reference to my remarks (pages 28, 29) on Mr. Griffith's Geological Map of the past year, that in his larger Map, now complete, he has transferred a large portion of the strata, formerly designated by himself and others *transition*, to the old red sandstone, a most important change, which must be considered to spring from the generalizations in Devonshire of Professor Sedgewick and Mr. Murchison. Mr. Griffith has also stated, that the yellow sandstone and shales are equivalent to the lower portion of the carboniferous system, which is the adoption, in other words, of Professor Phillips' arrangement.

J. E. P.

II. *On the Alteration produced in a Conglomerate of the Poikilitic Series near the Church of Llanfair Iscaer, in Caernarvonshire, by the Contact of a Mass of Trap.* By JOSHUA TRIMMER, Esq. F.G.S.

ON the shores of the Menai Straits, between Moel y Don Ferry, and Caernarvon, there is a narrow stripe of red conglomerate and marl, which has been slightly noticed by Professor Henslow, in his paper on the Geology of Anglesey, as belonging to the new red sandstone series.

Some doubts have since been raised, whether a part of the conglomerate nearest to Moel y Don Ferry, is not interstratified with some sandstone beds, of the carboniferous limestone.

Waiving this discussion for the present, on account of the obscurity of the section, which has given rise to this supposition, I shall adopt his designation of the whole deposit, and confine the present paper to a description of its lithological characters in its unaltered state, and of some changes which have been produced in it by the contact of a mass of trap, near the church of Llanfair Iscaer, about two miles from Caernarvon on the Bangor road.

This appears a subject of considerable interest at the present moment, connected as it is with discussions respecting the metamorphic origin of some of the crystalline rocks, with the discoveries of Mr. Murchison, as to the relations of some of the silurian strata to igneous rocks on the Welch border, and with the chemical experiments lately carried on by the Rev. Vernon Harcourt, the late Dr. Turner, and Mr. De la Beche.

Professor Henslow, in his admirable Memoir on the Geology of Anglesey, shewed how, by the intrusion of an igneous rock at Plas Newydd, a shale of the carboniferous limestone has been converted in one part into porcelain jas-

per, and in another into regularly crystallized garnets and analcimes.

He likewise shewed, that these changes had been effected without actual fusion, the forms of the shells in the shale being sometimes preserved, when the shale itself was converted into a concretionary mass of analcime. He likewise pointed out this remarkable fact, that while in some instances the presence of dikes has produced these alterations, it has in others occasioned no change whatever in the rocks with which they are in contact. In the case which I am about to describe, which has not been noticed by Professor Henslow, although he has laid down nearly every trap dike on the shores of the Menai, we shall see that a loose conglomerate, scarcely more consolidated than some of our diluvial gravel, has been converted into a mass so nearly resembling many of the subcrystalline breccias and conglomerates which in Caernarvonshire and Ireland are interstratified with the slate, that were hand specimens exhibited to a cabinet geologist, he would probably pronounce them to have formed parts of a rock, of which the base, at least, had been precipitated from a fluid holding their elements in chemical solution.

These changes produced in mechanical rocks by the intrusion on a small scale of igneous matter, led me several years ago to suspect, thatthe concretionary and subcrystalline character so common among the rocks of the Cambrian system in North Wales, had arisen from subterranean heat acting upon them during long periods, and I had become impressed with an opinion, that though some of the igneous rocks interstatified with the slate might have been tufas and breccias, formed from the ejectments of submarine volcanoes, or might have flowed as currents of submarine lava, while the formation of the igneous strata was in progress, or might have been intruded among them after their formation, yet that other rocks closely approaching them in character were purely

aqueous deposits, free from the intermixture of volcanic matter, and that they had acquired their crystalline and concretionary form from the slow action of large masses of molten matter in their vicinity; and further, that these changes had been effected at various periods, some while the strata consisted of gravel and mud, others after these beds had been consolidated. But though the district between the Menai and Snowdon, to which my observations have been principally confined, presents many phenomena favourable to this hypothesis, it is a district from which it is difficult to draw satisfactory proofs; first, because when a rock occurs having the appearance of being metamorphic, it frequently conceals the subjacent igneous rock, to which the alteration is attributed, and the presence of which can only be inferred from the numerous trap dikes by which the country is traversed, and which must have proceeded from some subternanean mass; secondly, because when a mechanical and crystalline rock occur on the same strike, though the regularity of strike, for which this part of Wales is so remarkable, renders it highly probable that the one has been converted into the other, yet the thick detrital covering with which the district is overspread, too often renders it difficult to trace the various gradations through which the change has been effected.

So soon, therefore, as I became acquainted with the outline of Mr. Murchison's observations on the border counties, it became evident that others better qualified to conduct the inquiry were engaged in the examination of similar rocks, in districts more favourable to the solution of the question, and I at once determined to abandon all thought of tracing out the changes which the older stratified rocks had undergone. At the same time the phenomena presented by the trap of Llanfair Iscaer appear of so important a character, as to lead me to hope, that some account of them may not be unacceptable, as insulated facts capable

of being hereafter woven into the chain of evidence, by which the metamorphic character of the crystalline stratified rocks appears likely soon to be as firmly established as any other geological truth.

The poikilitic rocks of Anglesey, and Caernarvonshire, are of very limited extent, being confined on the eastern shore of the Menai to the narrow space, never exceeding two furlongs in breadth, between the straits and the Bangor road. And on the Anglesey side, if they ever extended even so far inland, they must have been denuded, and some of the upper beds of the limestone on which they are based must have been swept away with them, for rifts in the limestone in some of the quarries within a hundred yards of the shore, are filled with brown diluvial gravel and loam, but contain no trace of the red marl. At the period when it was deposited, the Menai appears to have been a deep inlet open to Caernarvon Bay, and terminating near the Moel y Don Ferry, about four miles N. E. of Caernarvon, the extreme point in that direction, to which the red conglomerate extends.

This formation no where attains a greater elevation above the present high water mark than about forty feet, but it has evidently lost something of its original thickness by denudation, for in almost every section, its surface exhibits a deeply furrowed outline at the point of contact with the brown diluvial gravel by which it is covered, and in many cases it does not rise more than four feet above the level of the Menai. Some outlying patches of the same deposit have likewise been laid open in several places at the head of Caernarvon Bay, and from the shape of many of the diluvial mounds between the Clynog road and the sea, they appear to be based on detached portions of some horizontal formation like this.

From Moel y Don Ferry, therefore, to the neighbourhood of Clynog, we are able to trace the shores of the poiki-

litic sea, which differed very little from those now existing. The low chloritic rocks of Anglesey, prevented the extension of this deposit westward, the felspathic ridge of Caernarvon cut it off on the east, forming a low promontory, the eastern side of which, as well as the western, was washed by the sea of the poikilitic era, while other rocks of about the same elevation near the Clynog road prevented its extension to the N. E. The points at which this formation is observable at the head of Caernarvon Bay, are on Llanfaglan Common, and in a marl pit where it is raised for manure, between Bodfaen House, and the gate of Glyllyfon Park.

The deposit consists of two members, a conglomerate, and a marl, of which the former is the lowest. The conglomerate affords few traces of stratification, the marl is distinctly stratified. Its position may be said to be almost horizontal, dipping to the S. W. at an angle not exceeding 3°.

It has already been observed, that the north eastern limit of the formation, is near Moel y Don Ferry. The conglomerate is there seen in a coast section, for about 300 yards, and is described by Professor Henslow, as resting unconformably on some highly inclined beds of sandstone, belonging to the carboniferous limestone series. A fall of rock which has taken place since the district was examined by him, exhibits appearances (which, however, may be deceptive) of the conglomerate having the grit both above and below it. These carboniferous beds have been so much disturbed for a short space, that they appear to dip under the felspathic ridge to the eastward of them, which, as it terminates near Caernarvon, I shall call the Caernarvon ridge. (See section plate 1.)

The cliff of red conglomerate, as exhibited in this section, is about thirty feet high, and is covered by about ten

feet of diluvial gravel. The conglomerate consists of a mass of coarse pebbles, cemented together by red clay. (1)*

By far the greater proportion of these pebbles have a felspathic base (3 to 28) varying from granular to compact, and containing imbedded crystals of vitreous felspar. The prevailing colours are various shades of red. Some are grey and compact, some approach the character of hornstone, but all that I have examined are more or less fusible before the blowpipe, though none are so fusible as common felspar. The product is generally a grey, in some cases a black enamel. The conglomerate also contains pebbles of quartz, (29, 30,) trap, (35,) grauwacke, and grauwacke slate, (31 to 34.) I have detected a few pebbles of the limestone (36) of the neighbourhood, but have met with no pebbles which I could satisfactorily identify with the chlorite schist of Anglesey, or the violet roofing slate of Caernarvonshire. Beyond this, I shall not in the present paper enter into a discussion of the sources from which the pebbles of this conglomerate have been derived.

In proceeding along the shores of the Menai, in a S. W. direction from the section near Moel y Don Ferry above described, the shore for some distance is bounded by cliffs of sandstone belonging to the carboniferous series, highly inclined, and dipping towards the Caernarvon ridge. No marl or conglomerate is visible, but it may be concealed by the diluvial covering which supports a thick growth of underwood. In front of the house of Plas Llanfair, the disturbance which these beds have undergone, appears to have ceased, and the limestone series to have become nearly horizontal, as on the opposite side of the straits, for the cliffs disappear, and the ground slopes gently to the shore; but a little further to the S. W. the red conglomerate reappears,

* This and the following numbers, refer to a suit of specimens in the Museum of the Geological Society.

as a low bank about twelve feet high, covered with diluvial gravel. It here shews some traces of stratification, consisting of seams of marl a few inches thick, free from pebbles. (2) Another interval then occurs affording no section, but about 800 yards to the S. W. of Llanfair Iscaer church, a bed of red marl (37) appears, having its stratification marked by alternating bands of greyish green marl, (38,) the dip being, as has been already observed, S. W. at an angle not exceeding 3°.

The height of this cliff is about thirty feet, and the length of it about 300 yards. It is capped by about two feet of brown loam, and the marl, at its junction with the loam, is slightly furrowed. The rest of the intervening space between Llanfaer church and Caernarvon consists of a series of diluvial undulations, based on red marl, which is visible in several sections, on each side of the Menai.

Before the blowpipe, the red marl melts into a black, the green marl into a grey enamel. Both of them effervesce in acids. The marl cliff above mentioned contains several seams a few inches thick, of a fine conglomerate or coarse sandstone, (39,) the base of which is calcareous, and contains magnesia.

Such is the poikilitic formation of Caernarvonshire, in its original state. The space over which it has been affected by the trap extends for about 180 yards, along the shore of the Menai, near Llanfaer church. The first traces of alteration occur about 100 yards N. E. of the Church at *a*, (see the plan of this part of the shore,) where a string of fine-grained decomposing trap, varying in width from two to four feet, rises through the face of the bank, and may be traced on the shore down to low water mark. The conglomerate has been removed by denudation, for about four feet on one side, and ten feet on the other, of this string of trap, and the excavation is filled with brown diluvial loam, containing pebbles and boulders. On the sides of the

excavation that are furthest from the trap, the conglomerate retains its red colour. but about four inches of conglomerate adhere to the trap, which stands out in relief from the bank, and here it has acquired a slight purple tinge, is rather harder than the rest of the mass, but falls to pieces under the hammer. At *b* two strings of decomposing trap, similar to the last, have produced no change whatever in the adjoining conglomerate. They may be traced on the shore for nearly twenty yards, first converging, and then branching again till they disappear under a thick covering of shingle. At *c* are two strings of trap eight inches wide. That to the N. E. is lost under shingle, at ten feet from the bank, the other is visible for full thirty, when it branches into four strings, each about four inches thick, having hardened conglomerate entangled among them.

These strings are rather exaggerated on the plan, the total width of the strings and the included conglomerate not exceeding four feet. Between *b* and *c* the argillaceous base of the congomerate retains its red colour, but S. W. of *c* that colour is changed to a dull purple, passing into black, and some thin seams of marl, which mark the stratification, are somewhat indurated, and have assumed a brownish tint.

The alteration is greatest towards the bottom of the bank where it is nearest to the trap. The coarser parts of the conglomerate crumble under the hammer (40.) Specimens (41, 42) are from the finer grained portions, three feet from the beach. Spangles of micaceous iron may be observed in them when held in a strong light.

Specimen (43) in which these spangles are very abundant, and coat a joint, was taken within one foot of the beach and close to the string of trap. At four feet from the beach a thin seam of marl has acquired a slight brown colour, and is somewhat indurated, (44,) a similar seam of marl seven feet from the beach has scarcely lost its red colour (45).

Two strings of trap from six to eight inches wide, traverse this part of the beach at *d* and *e*. At *f* are two strings of trap about the same width as the last, and having a mass of conglomerate harder than the rest between them. They converge into one which may be traced on the beach for thirty feet. At *g* is another string of trap winding along the face of the bank, as represented on the plan. The composition of the trap, in all these strings, appears nearly the same, the only difference being, that some are in a state of decomposition on the surface, while others are not (46, 47, 48.)

At this point, *g*, the principal alteration in the great body of the conglomerate commences. It is marked on the plan by a deeper shade than the rest.

As we proceed towards the low terrace A, and the outlying rocks B, the argillaceous matrix gradually becomes blacker and harder, the lowest part being the hardest.

At the point A, six feet above the beach, it has assumed a stony character, but still crumbles under the hammer (49.)

At three feet above the beach, it is sufficiently hardened to have acquired the form of a brecciated rock, from the base of which the pebbles may be detached (50.) Minute spangles of micaceous iron sometimes line the cavities, from which pebbles have been removed. The fine grained portions resemble coarse grauwacke slate (51.) In specimen (52,) which is from the outlying mass B, the pebbles and the matrix are more intimately united: a smart blow of the hammer produces a clean fracture, which pervades them both, and they are not easily separated from each other. The relative heights of the portions of hardened conglomerate about this part of the plan will be better understood from an examination of the accompanying section, than from a detailed description.

We have now traced the passage of a bed of pebbles

imbedded in red clay into a conglomerate, having a black and strong base, but as yet no traces of crystallization have occurred, with the exception of the spangles of micaceous iron. These made their appearance at a very early stage of the alteration, viz.: when the argillaceous conglomerate had merely changed its red colour to a purple, and before it had become much indurated. A series of specimens will now be described, in which the change has been carried a stage further, and in which it is impossible not to recognize a likeness to some of the subcrystalline rocks of Snowdonia. Unless, however, we find a crystalline structure in the base of the conglomerate, we cannot be certain that it has arisen from the action of heat on a fragmentary rock, because crystals of felspar existed, as we have seen, in many of the pebbles of the unaltered conglomerate. In the specimens, however, which remain to be described, the base has become crystalline, and the felspathic matter of the imbedded pebbles has assumed a new crystalline arrangement; and lastly, a few will be noticed which can be called nothing but trap, but in which faint traces of a fragmentary origin are still visible. These specimens were taken from a portion of the shore marked C and D on the plan. It comprehends part of the purple portion, where a thin coating of hardened conglomerate covers the subjacent trap, and it also includes part of the shore, coloured green on the plan, as consisting chiefly of trap, but having small lumps of conglomerate adhering to it, blending with it, and appearing to have melted into it. Over the space E, no rock is visible but trap. This forms a nearly level surface between high and low water mark, partially covered with shingle, which is continually changing its position, the rock appearing through it in insulated patches. The last patch of trap that is visible through the shingle is about seventy yards S. W. of the outlying rock B. The very variable nature of the trap rock over this space,—

a circumstance which will be again noticed,—renders it probable that we no where see the original trap, if I may be allowed the expression, that the total absence of the conglomerate over the space E arises not so much from denudation as from its more complete fusion, and that the surface of the trap exposed is the result of this fusion. Unless we adopt this hypothesis we shall be driven to the conclusion, that the most hardened portions of the conglomerate are those on which the action of the waves and other denuding causes has produced the greatest effect.

Although the mass of trap has thrown off into the conglomerate those strings which have been described, it does not appear that the great body of it has burst through, or in any way disturbed the conglomerate, which seems to have floated on it as scoriæ would have floated on a mass of melted metal. Specimens (53, 54, 55) are from the lower part of the point between A and B. A fragmentary character still prevails in the finely comminuted matter constituting the dark base of the conglomerate in these specimens. Most of the small imbedded white fragments retain their angular shape. Dark spots are observable in the centre of some of them, and there are a few vesicular cavities, whence some of the more fusible fragments have disappeared. The large imbedded pebbles have undergone no alteration. In part of the base of (56) these vesicular cavities are very numerous. In a bright light many brilliant spangles are observable, which are probably micaceous iron.

Specimen (57) is a portion of one of the fine grained argillaceous seams which marked the stratification of the original conglomerate. To the naked eye it has the appearance of a hard grauwacke sandstone, having numerous small white fragments dispersed through a dark and somewhat compact base. In a bright light the glittering facetts of small crystals are discernible. Viewed through a lens it appears to abound in drusy depressions, often running into deep cavi-

ties surrounded with white matter. The minute crystals lining the depressions have a lustre approaching the metallic. This specimen fuses before the blowpipe into a glass, varying from white to black in proportion as the white or dark matter prevails in the assay. The white is the most fusible.

Specimen (58,) fine grained, more homogeneous, and of a lighter colour than the last, and fuses very readily, even when the assay is large, into a colourless glass. A natural fissure is coated with light coloured mica.

Specimen (59,) bluish gray, more compact than the last, and fuses less readily into a dark glass.

Specimens (60, 61, 62, 63, 64) are portions of the hardened conglomerate of different degrees of coarseness, in which the base and the pebbles are more intimately blended than in former specimens. The base is similar to that of (57 and 58,) but some of the drusy depressions are larger. When viewed in a strong light they sparkle with numerous small crystals, most of which are magnetic iron. A portion of the base of (61), near the label, more compact than the rest, has somewhat of a porphyritic aspect, but the crystals of felspar are not well defined. Many of the pebbles exhibit the fissured appearance so common in the old conglomerates of Snowdonia, the fissures being filled with veins proceeding from the base. These specimens contain nests of crystals of felspar, which have resulted from the rearrangement of the felspathic matter of the smaller imbedded pebbles. The surface of some of the larger pebbles is coated with a few scales of mica. These specimens were probably within two feet of the trap.

The three following (65, 66, 67) are from a part where the crust of conglomerate is thinner, and were almost in contact with it. In (65) a white imbedded fragment, three-fourths of an inch long, and one-fourth of an inch wide, is partially fused into the base, from which veins run into it. A portion of what has been one of the argillaceous partings

of the conglomerate, is of a dark green colour, having numerous small crystals, with a vitreous lustre dispersed through it, but has not lost all traces of its original lamination.

In specimen (66) part of the base consists of numerous small crystals of glassy felspar, imbedded in yellowish green carbonate of lime. They are very apparent in a spot from which the calcareous matter has been removed with an acid.

Specimen (67) affords several instances of an incipient blending of the pebbles with the base, which contains much crystalline carbonate of lime.

Specimens (68, 69, 70, 71.) In these the pebbles and the base are rapidly running into one another. In (68) a portion of the base appears to have been converted into basalt. In (71,) immediately adjoining the pebble on which the lable is fixed, the base contains well defined crystals of felspar.

It has been before observed that both the red and green marl and the thin seams of sandstone in the cliff to the S. W. contained much calcareous matter, and the same appears to have been the case with that portion of the conglomerate near the church, whence these specimens were obtained, for veins of yellowish green carbonate of lime traverse them abundantly.

In specimens (72, 73) the fusion of the pebbles into the base appears very nearly complete, giving rise to a white product, fusing readily into a white or gray glass, and traversed by dark veins and by veins of carbonate of lime.

Specimens (74, 75, 76, and 77.) In these the small white fragments have prevailed in the base, and the rock is of a lighter colour than specimens (60 to 64.) The white matter fuses very readily into a clear white glass. Much calcareous matter is dispersed through the mass, for both pebbles and base, but particularly the latter, effervesce in acids. In specimen (77) crystals of felspar are discernible in the base.

Specimens (78 to 83) contain many veins consisting of a mixture of crystals of carbonate of lime and felspar. These veins sometimes traverse several contiguous pebbles. Analogous circumstances occurring in a conglomerate, low in the slate series near Bangor, induced Professor Henslow, who had at first considered it a mechanical rock, to change that opinion, and to describe the pebbles as concretionary nodules. Specimen (79) contains in the base a crystal of glassy felpar a quarter of an inch long. In (80) a fissure is coated with hexagonal crystals, which appear to be impure, adularia being more fusible than common felspar.

Specimens (84 to 90) are from another portion of the shore marked F on the plan, and must have been nearly in contact with the trap. The base of them is white, sometimes inclining to green, weathers into a friable mass, easily rubbed to powder between the fingers, aud fuses with ease into a clear glass. Nests of small crystals of felspar that have resulted from the re-arrangement of the felspathic matter of the imbedded pebbles are very abundant. In some of the pebbles this change has only been partial.

Part of specimen (91) is more compact, and connects the six preceding specimens with the nine that follow. It formed in its unaltered state part of one of the argillaceous seams of the red conglomerate.

In (92,) though it is so hard that the point of the knife makes no impression on it, the laminated structure of a sedimentary deposit is still visible.

Specimens (93 and 94) have become quite compact, with an imperfect conchoidal fracture fusing into a white or greyish glass, and resembling compact felspar; the laminated structure not being wholly obliterated in (94.)

These specimens all contain crystals of felspar in small nests resembling those already noticed in the other specimens; but in many cases all trace of their having resulted from the re-arrangement of the matter of imbedded pebbles

has disappeared. The green colour of these specimens probably arises from minute crystals of augite intimately blended with the compact base, for veins and patches of a darker green than the base, which evidently consist of small crystals of that mineral, occur in (95 and 96,) these crystals become more abundant and well defined in (97, 98, and 99,) and in (100,) the transition into a very fine grained basalt is complete. As the above specimens exhibit the passage of the argillaceous seams of the conglomerate iuto fine grained basalt, so those from (101 to 111) seem to have resulted from the fusion of its coarser portions. They were obtained from that part of the shore where small lumps of conglomerate are found adhering to the trap, and consist of basalt, the fine and coarse grained varieties in the same hand specimen, traversed by veins of felspar and containing nests of felspathic crystals like those which have been described in many of the preceding specimens as having resulted from the imbedded pebbles. The fragmentary structure is most apparent in specimens (101 to 105,) and gradually disappears from (106 to 111.) The trap possessing these intermediate characters contains thomsonite (106 and 111,) garnet (112, 113,) magnetic iron (114, 115, 116).

The great mass of trap consists of two kinds, fine and very coarse grained. The former commences about six yards S. W. of the detached rocks B, the trap in the intervening space being nearly covered by a thin coating of hardened conglomerate. The fine grained variety, unmixed with the coarse grained, extends for about sixteen yards. It is traversed by vertical parallel joints from four to six inches asunder, giving to it a coarse slaty structure. Some specimens (117) retain traces of lamination, and appear to have resulted from the argillaceous seams of the conglomerate.

The coarse grained variety, (119, 120,) occasionally intermixed with veins and patches of a finer grain, occupies the

rest of the space over which the trap is visible, appearing through the shingle in irregular bosses, from three to six feet in diameter, generally exhibiting a decomposing surface. It contains zeolite, thomsonite, magnetic iron, and mica, the latter frequently in sufficient abundance to form one of its constituent minerals. This trap appears to agree in character with many of the dikes of Anglesey described by Professor Henslow, which were analysed by Cordier, and pronounced by him to consist of felspar and augite.

Some of the most altered portions of the conglomerate have been used to build the wall of the churchyard, and as recent storms have effected a breach in it since the series of specimens described in the present paper was collected, arranged, and examined, I have little doubt that a suite more decidedly crystalline might be obtained from the ruins; but an examination of those which I have been describing must convince the most sceptical on the subject of metamorphic rocks, that clay has been converted by the action of heat into rocks possessing the characters of grauwacke slate, compact felspar, and basalt, and that gravel with an argillaceous base has been converted into a subcrystalline conglomerate, so closely resembling those which in Snowdonia and Ireland are interstratified with the lower Cambrian slates, that we can have little hesitation in assigning to them a similar origin.

III. *Observations and Sections made in the District lying between the Mourne and Dublin Mountains.* By CHARLES WILLIAM HAMILTON, Esq., F.G.S., M.R.I.A.

MY original undertaking was to have made for this Society a section from Slieve Gullion to Kippure, with a view of clearing up the obscurity which appeared to me to hang over the relations between the granite of the Dublin and Mourne mountains, the slate which rests against it, and the limestone which overlies the slate occupying vallies in the neighbourhood of Dublin, Drogheda, and Dundalk. I found more difficulty in this task than I had anticipated, and that indeed it would be impossible to make one line of section accurately in the proposed direction, I was therefore obliged to make many minor sections in distant parts of the country, and the extent that I found it necessary to traverse, and the little leisure I had for working in so distant a locality, would have deterred me from making any communication to you upon the subject, if it were not for the conviction that it is the duty of every member to bring in to this Society the result of his summer's field work, and the feeling that where the observations I have made differ from those of Mr. Weaver, to whom we are indebted for the only description of this district which has hitherto appeared, it is of importance to myself to have them tested by being brought under discussion before the Society.

I shall now attempt to give you a general idea of the character of the country, and of the impressions which have been made upon me in the examination of it, reserving the details for a subsequent communication.

The northern portion of the district is that comprised between the parallels of Newry and Dundalk, embracing

NOTE.—The specimens exhibited with this paper are in the Museum of the Society, with labels indicating the localities.

the Carlingford mountains, Slieve Gullion, and the range of minor hills running from Jonesborough to Forkhill. The highest mountains are composed of granitic compounds of felspar, quartz, and hornblende, with a little mica occasionally appearing, but scarcely constituting a characteristic of the rock; the quartz and felspar are nearly white, and the rock varies in colour from a light grey to black, according to the proportion of hornblende which it contains; there is almost every shade of mineralogical distinction through which it appears to pass, on the one hand into the greenstones of undoubted dikes, and on the other into the slates which as indisputably lie stratified on the lower declivities of the mountains.

Slieve Gullion rises the height of 1893 feet above the sea, out of a plain which extends around it, for an average of about two miles to the foot of the surrounding barriers of Jonesborough, the Forkhill range, and the Fews mountains; this plain is covered and level, with the exception of several well defined ridges, which traverse it from Slieve Gullion in a south easterly direction, until they are lost in the limestone district of Dundalk.

The summit of Gullion is a fine mixture of minute crystals of quartz, with very little felspar, and enough of hornblende to give it a light grey tinge of colour; the same rock is found at Feoghill Etra and Feoghill Otra to the east of Jonesborough; here it is very fine, and bears the appearance of stratification; at a quarry close to Meigh, near the south eastern foot of Slieve Gullion, it is found so fine as to appear almost a clear silicious schist, lying in beds, with a direction 20° north of east, and divided into prisms by joints which are filled with a coarser granite containing some mica; a close examination, however, shews that this fine rock, the granite, and veins of a distinct greenstone, which lie irregularly parallel to the joints, pass gradually into each other, and leads one to suspect that these coarser beds may be only instances of a variety in the mode of crystallization

connected with the fissures of original jointage. At the western foot of Slieve Gullion there is a valley which runs in a curve round that side of the mountain from north to south; it consists of a rock differing from that of Slieve Gullion (which bounds it on each side of the valley and traverses it in veins) only in the great preponderance of hornblende, which is however vary variable; this rock is sometimes prismatic; the end of the valley corresponds with the end of the principal of those ridges which I have alluded to as crossing the plain.

A granite compound, coarser than that of Slieve Gullion, and containing a large proportion of yellowish opake felspar, constitutes the hills in the immediate neighbourhood of Newry; the ridge which runs south and parallel to the Newry river ends nearly opposite Warren Point, and trends round by Clermont Carn to Annaverna mountain; it forms also the greater part of Feede mountain, and occurs at the northern foot of Carrickbroad, one of the Forkhill range. From Carneen a Waddy, along the high ridge of Carlingford mountains, we find nothing but a syenitic compound of greenish translucent felspar and hornblende; the felspar is semi-crystalline, and bears a proportion of about two to one to the hornblende; it is very coarse-grained, and epidote occurs in abundance, although not distributed evenly enough to be considered as a necessary constituent of the rock; the Trumpet Mountain is a very coarse-grained syenite, differing from that last described in the size of the crystals of hornblende, and in the felspar being purely white and more opake, but still translucent at the edges; in it I did not find epidote. I shall now give some sections explanatory of the connexion between these granites and their overlying rocks.

At about half mile south of Newry, in the old road which runs along the Fathom Hills, we find a greenstone slate, direction E. and W.; this is succeeded to the south by a talcose

slate, similar to that which may be seen at Wicklow Head, on the sides of Brandon Mountain in the county of Kilkenny, and other places where slates are found in the vicinity of granite; this covers about a quarter of a mile of surface, but as the dip is not clear, the actual thickness has not been ascertained; as it approaches the granite, but where the rock still is evidently stratified, a remarkable change takes place, it is very fine-grained, but a minute examination shews, that the quartz and felspar are distinct, and scales of mica are mingled with the slate; this is immediately succeeded by the granite of the Fathom Hills. On the southern side of the Fathom Hills, at a turn of the Hill S. W. of Warren Point, we find slates lying immediately upon the granite, with an E. and W. direction: they are porphyritic, containing large imperfect crystals of vitreous felspar, in a fine-grained dark-green base. Slates are found abounding in similar concretions or crystals of felspar, chalcedony, and calcareous spar in various localities, associated with greenstone, and not remote from granite; among others I may particularize, Portrane, Lambay, and Dunganstown, in the county of Wicklow, districts in which the metamorphic slates appear to bear the strictest analogy to those under our present consideration. The valley running again to the N. W. from this point up nearly to the watershed line between the Bracket Mountain and Clermont Carn, the neck between Clermont Carn and Carneen a Waddy, and the valley along the watercourse descending from thence to Anaverna, consists of hard felspathic slates, striped green and black, with a direction 30° N. of E. and perpendicular dip; they are exactly similar in character to those which lie against the Mourne Mountain, between Newcastle and Kilkeel: the probability is, that they are doubled up between the two mountains, and where they are found on the slope of the hills, the dip is adapted to their contours. There is a very remarkable junction between the hard slate and the syenite; about half way up the moun-

tain, immediately over the town of Carlingford, the actual point of junction is scoriaceous, but at this place, the syenite appears as if regularly stratified in beds, conformable to the overlying slate.

In tracing the junction along the southern slope of the Carlingford ridge, at a river course running south from Ballinteskin, there is a good opportunity of observing the connexion between the syenite and slates. In a descending series, we find a white compact felspar changing into dark red from the effect of weathering. A dark slate containing irregular masses of yellow felspar, which gives those parts of the rock an appearance exactly similar to that of the granite compound of Clermont Carn. a dark slate distinctly stratified and lying against the syenite, described as constituting the Carlingford ridge, this latter breaks through it in dikes. Fig. 1 is a sketch of one of the largest. I have called these stratified rocks slates, because to the naked eye they have that appearanee, but upon examining them with a lens of high power, it may be clearly seen that their constitution differs in no respect from that of the coarse-grained syenite of Carlingford mountains, except in the size of the component parts.

The section from the Trumpet Mountain along the watercourse running from Carneen a Waddy, is very instructive (Fig. 3.) I have before described the Trumpet as a coarse-grained syenite, consisting of a white felspar and hornblende. To the north of it is a synclinal in which the upper beds are hard slates, and in the lower, the structure becomes gradually more crystalline, and spots appear in the rock of a lighter colour, owing to the presence of masses of translucent greenish felspar. One of the lowest beds has exactly the character of the rock described as lying against the granite on the east of Fathom Mountain. Between these greenstone slates, and the coarse syenite of Carneen a Waddy, is interposed a rock very different from either, consisting of semi-crystalline felspar, very transparent, and of a rich brown,

colour, passing into wine yellow; it contains hornblende and quartz, but in very minute quantity, it weathers into an opake dingy yellow, and it is so subject to weathering, that it seldom presents its original character, and this circumstance distinguishes it strongly from the syenite upon which it reposes, and upon which the weather has scarcely any effect, except that of producing disintegration. We find it occupying the Ben rocks, Clermont Carn, and all the high ridge from Annaverna to Jonesborough; in descending from the Ben Rocks to Ravensdale Bridge, we meet with the same succession of slates, consisting of a dark coloured base, apparently containing hornblende with crystals of vitreous felspar; first coarse, and then finer in grain, until the transition into the hard slate is perfect.

Before describing the rocks to the west of the road from Dundalk to Newry, I may allude to the analogy which exists between those already mentioned, and those which are found in the Mourne mountains: a reference to Mr. Griffith's Map will shew a number of immense dikes, 200 or 300 feet in width, proceeding to the east from Slieve Donard, and other mountains forming the chain that extends from Newcastle to Kilkeel. I had only time to examine one of these, and that the nearest to Newcastle. Slieve Donard is composed of a granite, about nine-tenths of which may be white felspar, through which are interspersed crystals of hornblende, mica, and quartz, in variable proportions; quartz is the least characteristic mineral, the grain is fine, and it is only in fissures and veins that the large crystalline specimens of felspar, quartz, beryl, and topaz, which adorn mineralogical collections, are found: these mountains are surrounded by slates, (which Lieut. James, R. E., correctly described to your Society as abutting against the granite hills, and which at Newcastle have a direction of 49° east of north, at the first dike 41° east of north,) which are exactly similar to those described as standing on their edges between Clermont

Carn and Carneen a Waddy—hard, felspathic, and striped light and dark coloured. In pursuing these slates along the coast to about a quarter of a mile north of Bloodybridge, we find their course interrupted by a rock, the relations of which to the slate I cannot clearly see; we first find a chasm of about ten feet wide, of great depth, and running 22° south of east, the north wall of it consists of the section of the slates at right angles to their direction; the southern wall of a white compound of quartz and felspar, the quartz predominating, it contains a trifling proportion of minute crystals, apparently of hornblende and epidote, it lies in beds against the mountain, and these beds are contorted; in one place I saw patches of slate lying conformably upon the outermost beds. About 150 yards from the beginning of this porphyritic rock there is another chasm running parallel to the first, the southern wall is represented in Fig. 4; *b* is the quartzose felspathic rock, which at *c* is rudely columnar; *a a* are masses of slate exactly similar to that outside the dike, retaining their cleavage; one of them is fifteen feet long by six feet high, the porphyry itself has a distinct cleavage nearly perpendicular and at right angles to the principal joints. Twenty or thirty yards further to the south we find a dike of compact felspar of a light grey colour; it contains crystals of quartz thinly scattered through a base, which has probably less alkali than is usual in the mineral called compact felspar, as it is fusible before the blowpipe only in minute scales and with great difficulty; this dike traverses the beds of felspathic quartzose rock, and tilts them in opposite directions, as shewn in Fig. 5. A little further on this fine rock is so blended with the coarser variety, that we are obliged to conclude them to be of cotemporaneous origin. About thirty yards further the slates occur again, with a direction 40° north of east, and dip to the south; here the felspathic quartzose rock is seen lying upon them unconformably as in Fig. 6, and this is the varied ap-

pearance of that which has been hitherto described as a porphyritic dike.

I now return to the chain of hills running on the west of the Dublin road from Jonesborough to Forkhill: next immediately over Jonesborough is a black fine-grained rock, with what appears to me a decidedly arenaceous character; but it contains also little patches of greenish felspar and nodules of quartz. I could find no abrupt parting between this and the light-coloured and very purely crystalline mixtures of quartz, felspar, and hornblende, which compose Feoghill Etra and Feoghill Otra; in crossing over to Feede Mountain I found a rock resembling that of the Clermont Carn, and Feede Mountain itself is a long ridge of yellow felspar, quartz, and hornblende, rather coarse-grained, and in which the felspar greatly predominates; on the southern declivity of this hill I found alternate beds of a dark compact trap, *a a*, and this granitic compound, *b b*, interstratified and dipping into the hill, as shewn in Fig. 7; the dark beds are a very fine mixture of white translucent felspar and black grains, which I conclude to be hornblende, though they are too minute to admit of being determined with certainty; the constituents of the two rocks are nearly the same, except that in the coarse-grained variety the felspar is more opake and yellow; if one must be considered as an intruded rock, I think analogies which I shall subsequently point out give the balance of probability to the coarse-grained; but although at this particular point they appear distinct, yet in others they pass so much into each other, and into the slates which are found at the base of the hill, that I cannot consider them in any other light than as of cotemporaneous if not identical origin; from Feede to Forkhill the rugged heights are composed of a porphyry, which evidently rests upon the micaceous granite found at their northern bases; it consists of a compact quartzo-felspathic base, very similar to that described as forming the finer parts of the dike near Newcastle; it is

variable in colour from dark to light grey; through it we discriminate small crystals of transparent felspar and quartz; it is identical in appearance with the porphyries of Caernarvonshire, and answers Mr. De La Beche's description of the Cornish elvans; it is a conglomerate, and contains rolled pebbles of a greenish slate; in some places, as at Carrickinaffrin, south of Forkhill, it is regularly divided by joints perpendicular to each other into prisms of about one foot square; in most it has some appearance of stratification, or at least of lying in beds. In the river which turns Balriggan mills, at about one mile and a half south of these hills, we find a red sandstone conglomerate, which directly underlies the limestone, and rests unconformably upon the green hard slates, which intervene between the limestone and Forkhill range; it consists of grains of white transparent felspar and quartz, with ferruginous matter and rolled pebbles of greenish slate. I think that an inspection of the specimens of these sandstones and the porphyries of the Forkhill range will leave no doubt upon the mind of any one, that this latter is merely a modified condition of the former.

The slates in the immediate neighbourhood of the porphyry, as may be seen in the south of Carrickinafrin are very different from those which underlie the sandstone, they are hard, compact, and broken into angular fragments, so as to assume the appearance of an omogeneous breccia. Between these slates and the porphyry we find in many places along the junction a remarkable conglomerate which consists of a base of apparently the detritus of slate rocks containing large irregular fragments of granite; hand specimens may be found containing the granite, porphyry, and slate in such intimate union, that it is hard to say whether the granite structure was original or superinduced upon particular pebbles or parts of the conglomerate. In the centre of Carrickbroad and at the very summit we find two irregular eminences which are recognized at a great distance as the features of that

range, and are known by the name of Diacle a worre. Here we have a curious mixture of the brecciated slate and the granitic conglomerate, twisted and woven together. In a country which is evidently so much disturbed, and among rocks in which the traces of stratification are so nearly obliterated, observations upon the dip and strike are not much to be depended upon, but I may allude to the fact, that the slates appear to have a general direction included between 5° and 15° N. of E. and the sandstone at Balriggan Mill and the porphyries are included between 10° and 35° E. of N. The section in a ravine through which the old road to Jonesborough runs, is given in Fig. 8, embracing an extent of about 150 yards. *a*, Fig. 4, is a slate hanging to the S. of which the upper part is distinctly in thin beds, and has a granular appearance; at *b* the structure becomes crystalline and globular, minute nests of hornblende are distinctly visible, and larger crystals of white felspar; at *c* the porphyry has the character of that constituting the range of hills; and at *d* it consists of flat thin plates of opake greenish felspar, sometimes half an inch broad in a base of semi-crystalline hornblende.

Having thus described the most striking characters of the rocks which in this district occupy broad spaces, I shall proceed to notice very briefly the dikes which traverse them. On the road from Newry to Dundalk, on the top of the hill about one-quarter of a mile from Newry, a very remarkable dike may be seen traversing the granite; it is about twelve feet wide, carries large masses of granite along with it, and the flat rhomboidal prisms into which it is divided arrange themselves perpendicularly to the masses of granite, whether included boulders or walls: at this point it appears to run to 30° E. of S.; the same dike may be seen to the N. of the road. Further on there is another dike with the same direction, but not above fourteen inches wide; these appear to be a fine-grained mixture of white felspar and hornblende; the dikes which intersect the lime quarries at

Carlingford are similarly composed. In a district so full of these dikes it is unnecessary to describe more than a few instances; but the fact which struck me most forcibly was, that the prevalent direction is to the S. of E. or rather the E. of S. and the thinning out of the dikes in that direction proves that they must have flowed from the N. W. Every lime quarry in the neighbourhood of Dundalk is traversed by these dikes; in some places, we find them in beds of equal thickness, lying between beds of limestone, so that they might pass for interstratified deposits, but where the quarry is sufficiently open the termination of the sill appears as in Fig. 9, or other forms equally indicative of obtrusion. In some quarries, as that to the west of Bellurgan, the trap has burst out in greater masses, the strata of limestone are tossed in every direction, and the limestone itself, in connexion with the trap, becomes granular and semi-crystalline.

Fig. 10 represents a curious development of trap seen in the cliffs which overhang the northern edge of the river; about a quarter of a mile above Balriggan mill the limestone, which is unaltered and very encrinal, appears on each side of this dike, which extends about fifty or sixty yards, to dip in under the trap; some beds of strata in immediate connexion with the dike are indurated, the dike itself is composed of large upright angular prisms, which present salient angles to the observer; the faces of these prisms are composed of smaller prisms, arranged with their ends outwards, giving them the appearance of brickwork, but the most remarkable circumstance in this dike is, that on examination with a lens it appears to be granular, and not distinguishable from the sandstone described as filling the bed of the river at the mill; except in its jointed structure and fineness of its components, it is quite different from the highly crystalline greenstones before described. I shall only refer to one more dike, which is represented in Fig. 11, and embraces a portion of about fifty yards of the side of the road from Roche's Castle to Forkhill; it is of the fine-grained syenitic

character, and traverses slates in the manner represented; the slates which are nearest to it are highly calcareous, and appear as if the effect of the trap was to make them give out the calcareous matter which crystallizes in all the joints; many of the joints are polished as slickensides; at a distance from the trap calcareous bands are rare.

I shall reserve the slates and limestones to the south of Dundalk for a second part of this paper, and only observe, that in Lambay, on the Portrane shore, and the east of the County of Wicklow, the same irregular graduation of the original arenaceous rocks into porphyres, containing crystals, and concretions of felspar and quartz, until they pass into crystalline greenstones or compact quartz, is distinctly traceable. Another observation, to which I attach some importance, I may allude to, as it will assist us in reasoning upon the facts already described, although I shall reserve the details and proofs for another evening; it is that the positive thickness of the slate formation has been generally over-estimated. Cleavage and diagonal lamination have been frequently recorded as planes of stratification, and as an instance of the mode in which the same beds follow the irregularity of the contour of the country, I may mention the result of very careful observations, which convince me that the stratification of the altered slates which compose the island of Lambay might be familiarly illustrated through the means of a model representing the irregularities of its shape, with a many folded wet cloth thrown over it as a nucleus. Mr. Griffith has also expressed a wish that I should attach to this part of my paper the general result of my observation on the boundary of the calp district; this I can do in a few words. In the Queen's county I have made sections of the chain of hills which are represented in the railway map as running from near Stradbally to Timohoe, and from Killone Hill near Bally Brittas towards Abbeyleix. These hills give very clear good sections of between 500 and 600 feet of limestone lying

immediately below the Kilkenny coal field; it agrees exactly with Mr. Griffith's description of the upper or splintery limestone; it contains subdivisions distinctly marked by their mineralogical character and the prevalence of particular fossils, and these distinctions I have found to be constant to similarly posited beds over the whole area that I have examined.

The same limestone occupies the area comprised between Lough Derevaragh, the slate hills in the neighbourhood of Oldcastle, and the chain of hills running from Loughcrew to Fore and the south eastern end of Lough Derevaragh in the counties of Meath and Westmeath, and constitute the hills which lie between Moate, Ballymore, and Kilbeggan, in the county of Westmeath; it rests upon the calp or black impure limestone and shales. I have given two sections, one in the Queen's county, (Fig. 13,) and the other in the county of Westmeath, (Fig. 12,) to shew the character of the stratification; that one from Loughsheelin to Carrick embraces an extent of about nine miles, it exhibits two lines of disturbance, which I have traced for some distance, and shall describe minutely on a future evening.

As there may be some of our members present who have not read the more recent works upon Geology, I think that before I proceed to draw those deductions which I believe to be warranted by the facts I have laid before you, it may be well to explain very briefly the opinions at present generally adopted respecting the class of rocks which I have been describing. The diagram which forms the frontispiece to Mr. Lyell's Elements of Geology may be taken as a fair representation of the state of the science up to the past year; the distinction between stratified and unstratified works is there distinctly maintained, and the exterior of the earth's crust is described as constituted of successive layers of gradual deposits of materials held by water, either in solution or mechanical suspension. These regular

layers are supposed to have been at different periods and under different circumstances disturbed and broken through by currents of lava flowing in a strata of igneous fusion from the interior of our globe; it is supposed that these lavas, derived all from the same source, have in cooling assumed different characteristics, according to the circumstances under which the cooling process took place, and that the volcanic matter irrupted at great depths and under great pressure of matter, either fluid or solid, has assumed the appearance of granite and greenstone, while that which flows only under atmospheric pressure presents itself to our view under all the varieties of modern lava, scoriæ, &c. It may be bold to question the authority of the ablest and most philosophical of English geologists; but I must say that I think this diagram is calculated to convey an idea very different from those which he has put forward in the body of the work, into which he has woven the discoveries of Keilhau, Cotta, and other continental geologists. There is another point upon which it appears to me that not only this diagram, but the tables given in most elementary works, are calculated to convey to the learner erroneous impressions of the thickness of the rocks which have been seen by man. If we turn to Professor Phillips' last work, we find "a table or section of the series of strata which constitute the crust of the globe, *placed* in the order of their succession downwards from the surface of the most recent aqueous deposit." Now, in this table the thickness of the fossiliferous beds alone is estimated at above six miles. The grauwacke and clayslate systems developed in Wales, the North of England, and South of Ireland cannot be less than four miles, and the necessary conclusion from Mr. Lyell's diagram is, that from at least that depth the plutonic and volcanic rocks must have issued; but it is of importance to observe, that these formations have nowhere been seen all together, and if we consider that at any former æra the surface and occupation of the globe was

probably as varied as it is at present, and that the untroubled bottom of the ocean may have been the place of the finer arenaceous deposits, accumulated at a depth unfavourabe to the existence of animal life, while the shores of that ocean were lashed by waves capable of wasting the rocks and producing rude conglomerates; and while embryo limestones were accumulating in the coral reefs and river deposits, forming extensive deltas. When we consider how distinct are the species of plants and shells, which would enter into the composition of recent marls formed in Sweden and South Africa, we may well doubt whether there has not been an overstatement, and whether many of those which have been laid down as successive, have not been in reality cotemporaneous formations. This last year has, however, produced two works which will tend to modify considerably the views supported by Mr. Lyell's Diagram, Keilhau's Gaea Norwegica, and Cotta's Geognostiche Wanderungen; and when I state to you that to every part which I have described I have found a parallel in Keilhau's accurate and full description of the rocks in the neighbourhood of Christiania, I may mention that my observations were made before his work was published, as it shews that mine were not made in support of a theory, but forced upon me in opposition to the opinions which I had already imbibed.

The most striking parts in Keilhau's work are the proofs he brings of having found:

1. Hard slates passing into hornstone and crystalline limestone, as a continuation of the same beds, which at no great distance appear as soft clay slates and ordinary lime stone.

2. That in rocks so altered the divisional planes of stratification disappear, but the joints become more distinct.

3. That those slates which when unaltered are simple alum slates, are altered into chiastolite slate.

4. That the gradual transition may be traced in strati-

fied rocks from a soft slate into a granitic compound of quartz, felspar, and hornblende, which has been described by Von Buch as a fine granite; and that, in fact, the granitic and syenitic rocks which he describes can "*in no way be supposed to have flowed from the centre of the earth in a liquid condition;* but that the crystalline types are in unbroken continuity with the stratified rocks, and are no more than the last members in a series of progressive modification. All the transitions which he mentions, in describing the granite, are equally found in the greenstone and porphyry districts, and his final conclusion is, that where we now see extensive granitic districts, with their offsets and outlying masses, there existed formerly the same rocks which are found unaltered in other parts of the district, namely, that the beds which now form the granitic districts were formerly the same with those which occupy at present the slate and limestone districts; that these all consist of rocks, the induration of which must have taken place at a very early period, as they all have a considerable dip; and that they, at a time of which we can form no conjecture, with an object which is equally concealed from us, and by processes which time alone may reveal, without undergoing the least disturbance in the strata and dips of their beds, were changed, over greater or less areas, into crystalline silicates, into syenites and granites.

When we consider, also, the great change which has taken place, the power of the chemical agents which were at work, we shall not be surprised at finding that these altered rocks were at the point of contact with those overlying them enabled to penetrate and fill the crevices occasioned by the expansion of gases or mere mechanical violence, and so give rise to the appearance of dykes and veins.

In Cotta's description of the neighbourhood of Meissen, near Dresden, a district well known to tourists under the name of the Saxon Switzerland, I find every specimen which

I have laid before you, every variety of porphyry, greenstone, and granite described as occurring in similar positions. So that the conclusions which he has adopted may be applied to our own country. The most important of them, and the only one to which I shall refer, concerns the granite of Weinböhla, which has long been supposed by geologists to be an instance of granite overflowing as a lava, the quadersandstein, a member of the greensand formation; his description, however, leaves us the option of concluding that the granite may have been an underlying bed reversed along with the green sand, and an oolitic bed which lies between them. If we go to the other side of the Atlantic, we find the metamorphic theory gaining strength, and founded upon facts exactly similar to those which I have described. I shall only refer to Professor Roger's Survey of the State of New Jersey, pp. 161 to 164. To return to our own country, we have seen proof of gradual change in the slates and conglomerates which I have attempted to describe, in which beds similarly stratified and equidistant from the overlying rocks first lose their soft character and become more compact and crystalline; in the different stages of crystallization separation takes place between the pure quartz and that compound of quartz and alumine, called felspar; small portions of lime and iron combine with quartz to form hornblendes and augites, and these simple substances are combined in endless variety until every form of granite, syenite, and greenstone is produced. When we have thus, in an unbroken chain, traced the stratified rocks downward from arenacious deposits to crystalline greenstone, we may, I think, soundly reason upwards, where we only meet the latter, even in dikes, and conclude that these also were originally of mechanical origin, and that the dikes which traverse all these rocks, even including the granite, owe their origin to the partial fusion of some rock which underlay that, from the alterations of which the granite has proceeded. If we turn to the geolo-

gical map, and take the carboniferous limestone as a standard from which to measure thicknesses we shall find, that a depth of above three miles is, in the south of Ireland, occupied by the cambrian slates, and conglomerates, while the same position is in the north and west taken by granites and syenites; and that the granite is unconformable to the slates which rest against it, does not necessarily involve a massive obtrusion, as the same unconformability is seen in the southern slates and conglomerates to those highly contorted slates which overlie the red sandstone of the Gaulty mountains, and occupy the country between them and the south of the county of Cork, a formation which I suspect to be identical with that occurring in the country between the Mourne and Dublin mountains. I have described the conglomerate structure of the porphyry of the county of Armagh, and the arenaceous character of a columnar dike. I do not find in Mr. De La Beche's account of the cornish elvans any reference to included boulders, but at page 177 we have the remarkable passage, "at the termination of a long dike extending about nine miles to the eastward of Penstruthall, where it cuts through the granite, even the porphyritic characters become lost, and the substance not unlike some arenaceous rocks; it is white and rather friable; a fine grained compound of quartz and felspar: a short distance west, however, the elvan is a well characterized porphyry."

The course of the dikes in the Slieve Gullian district is more or less approximate to a line from N. W. to S. E., so that they cross the prevailing strata of the country which is N. E. to S. W. It is particularly desirable that observers should mark the course which the dikes have taken, and which may be easily gathered from the point towards which it thins out and ceases. I mention this because I do not find that it has been sufficiently attended to. That the course of dikes should be at right angles, or nearly so, to the general axis of elevation in any country, is in exact accordance with

Mr. Darwin's observations upon facts in America, and Mr. Hopkin's *a priori* arguments. I shall now conclude with the hope, that, however imperfect may be the ideas I have attempted to convey to you, they may at least serve to excite attention to the successful labours of foreign geologists, and a zeal to make our own country a field for unravelling the mystery, as yet hanging over these, the most interesting of geological phenomena.

IV. *On the Contact of Mica Slate and Limestone, at the Rosses, near Sligo.* By Archdeacon VERSCHOYLE, A.M., F.G.S., M.D.G.S.

THE varying opinions on the origin of granite, and those speculations on the causes which produced the peculiar structure of mica slate, at present prevalent, render accurate observations on the contact and connection of this latter rock with others, peculiarly interesting and desirable. Some theorists have supposed it to consist of argillaceous slate which had assumed a crystallized structure, the component parts having entered into new combinations under pressure and heat not sufficiently intense to efface the schistose cleavage, though it favoured the exercise of new affinities among the ingredients of the rock; it is certain, that in the mullet of Erris, mica slate graduates into granite through the intermedium of gneiss, while this very formation of granite in another part of the boundary between them, protrudes intricate veins through that mica slate, into which it passes insensibly elsewhere; from these facts some might infer a common and simultaneous origin, while others would appeal to the veins as evidence of the prior formation of the schist. Amidst these doubts and conflicting opinions, observation becomes our best guide, and I am therefore induced to lay this communication before the Society as the fruit of last summer's researches.

The neighbourhood of Bomore and the Rosses, near Sligo, affords an unusually favourable opportunity, rarely attainable, of viewing the appearances and effects produced by the contact of mica slate with the superincumbent carboniferous limestone; for, in most instances, the lower beds of this formation, the layers of shale and grit, with the subjacent strata of old red sandstone and conglomerate be-

ing interposed, prevent that contact with the micaceous schist by which chemical changes might be produced in the calcareous rock, either from heat modified by compression, or the presence of water aided by other influences in actual operation at present.

The peninsula of the Rosses forms the northern boundary of the harbour of Sligo, the channel by which shipping have access to the town passing along its southern shore; the northern declivity falls rapidly to Drumcliff Bay, and the Atlantic Ocean washes the sandy beach of Bomore, forming its western extremity, flanked to the north and south by rocky points of limestone. Proceeding from Sligo, westward, by the road to the Pool, where ships of heavy tonnage anchor, the observer arrives at the Ballincar mills, about two miles and a-half from the town; on the shore here, at high water-mark, the mica slate is first seen; in this place it is more granular and less micaceous than usual, verging on sandstone; but on tracing it up the road to Cregg House, and thence to the summit of the hill, above that leading to Drumcliff, it gradually becomes more schistose and micaceous, presenting a well characterized mica slate, occupying from this place, the summit ridge of the peninsula stretching westward to a small lake on the race course of Bomore, where the sandy plain commences, which extends to the beach, on which the open sea breaks; the limestone runs parallel to this range on the north and south, dipping from it to the strand, and in general ending abruptly, at the boundary of the mica schist in a broken escarpment, as if disturbed and fractured, the fragments being dispersed and carried away; the mica slate lies below it in massive prismatic blocks, affecting a rhomboidal form, the vertical joints bearing about 10° to the west of north, and in general uniform in direction and dip; it is much veined with quartz, and frequently contains schorl and garnet; the limestone along its boundary considerably altered, shattered, and traversed by veins of calc

spar, in many places iridescent, bearing the aspect of having been heated and partially calcined. On the north coast of the Rosses, above Drumcliff Bay, it dips 50° to the north, and is accompanied by calctuff, and marl, a very usual attendant on trap and other igneous rocks, when passing through limestone; the springs which deposit the carbonate of lime rise in the face of the declivity, and probably issue from the junction with the mica slate.

The surface of the ridge is strewed with angular blocks of the schist, little worn, and of considerable magnitude, probably averaging 100 cubical feet, and identical with the subjacent rock in composition; and on the shore to the east of the mills, the banks are clay and gravel, containing large rolled boulders, chiefly limestone, some of them large, from eighty to 120 cubical feet; and, where springs occur, a deposit of calc tuff is seen, encrusting the grass and plants over which the water flows, and cementing the gravel and shells on the beach below. Along the north boundary of the demesne of Cregg, a lane proceeds to the westward, skirting the junction of the limestone and schist; by this road the observer soon arrives at a shattered facade of calcareous rock, rising from a narrow marsh, formed by abundant springs issuing from the mica schist, which crops out to the right or north; passing on along this cliff, the plain of Bomore opens to the west, stretching on to the sea shore; and above the lake which terminates this plain, on the east, in a narrow road or path deeply cut across a small knoll, crowned by a Danish fort, the junction of the mica schist, and limestone is well displayed: the latter rock has been altered in colour from the usual tint of bluish grey to a light yellowish brown or drab; its fracture has become crystalline, its texture sandy, and, in fact, the rock has been converted into dolomite, containing about thirty-seven parts of lime in the 100. No very evident alteration is perceptible in the mica slate, it is rather softer than elsewhere, shewing more ten-

dency to decompose, and the iron has separated abundantly, appearing in all the rifts and cavities as dark-brown oxide in soft concretions, crumbling easily when handled; from the appearances here, combined with the occurrence of dolomite among the limestone at Ballyshannon, at its junction with mica slate, this latter rock may be inferred to exert an influence in its production, and to contribute in the introduction of magnesia into the calcareous rock—from the small lake here a steep bank runs westward about 100 feet in height above the race course, composed of rubble of mica slate, iron ochre, quartz, fragments of ferruginous clay, of a dark red colour, and terminating at the shore in a low range of cliffs of limestone and chert, or black horn stone, in alternate layers and about equal quantities; this is a very peculiar rock, the siliceous portion is so generally disseminated through it, though not mixed, the layers or plates running into each other continually, sending rude columnar projections to those above and below, as I have seen flint occasionally appear in chalk; to this succeeds sandbanks, blown up in drifts by the storm, till the limestone rock is again exposed south west of Elsineur, at Deadman's Point, which contains no chert, and differs in no respect from the calcareous mountain rock of the district; on arriving here the observer must be much impressed with the contrast between the state of this limestone and that which he had just examined, in contact with the schist, which bears very much the aspect of a ruined lime-kiln, in the wall of which is exhibited the effects of heat varying with the materials employed. As in the east Pyrennees, the lias and chalk become charged with iron ochre, when near the granite, so here, in the neighbourhood of the mica slate, the limestone contains nests of red oxyd of iron and traces of magnesia, while the calc spar which occurs therein, is opaque and iridescent: whether the beds at Bomore Point, accompanied by chert, have been altered by a similar influence may deserve careful research;

but those which are seen at the north and south points of the Rosses present no trace of change. The fractured strata of rock which flank this ridge of mica slate, and dip rapidly from it to the north and south, suggest the surmise that its sudden elevation from below may have caused their present inclined position, while its strike and the bearing of the broken faces of the limestone being parallel to the system of trap dikes which traverse the Sligo district, may seem, on more careful and detailed examination, to indicate some connexion between their source: both appear to have originated from below, and to have elevated the overlying beds of rock through which they have been erupted, while the force by which they were impelled evidently acted in a longitudinal direction from east to west, confined to narrow limits: the presence of dolomites in those beds of limestone, which lie in contact with mica slate at Ballyshannon, at Bomore, and other localities, viewed in connexion with the occurrence of serpentine, which affords forty per cent. of magnesia, where the trap dyke at Dromahair traverses the micaceous shist, seems to point out the latter rock as the source from which that earth has been derived, and on this account, a chemical examination of its ingredients is very desirable, as talc may be disseminated through the schist in sufficient quantity to account for its presence, though analysis indicates none in mica.

The inlets of Sligo and Drumcliff Bays, which bound the district of Ballincar and the Rosses, on the south and north, viewed with a reference to the position of the valleys in the mountain range of Benbulben, suggest speculations worthy of notice. The picturesque lake of Glencar occupies a continuation of that depression in which the bay of Drumcliff is situated, and its surface stands at a level of ninety-seven feet above the sea. Sligo Harbour is the termination of the valley containing Loughgill, which divides the south portion of Benbulben from the eastern extremity of

that primary chain, the Ox mountains. The aspect of Benbulben is peculiar, the summit flat, the sides nearly perpendicular, forming precipices of carboniferous limestone, in which the strata appear to be undisturbed as they were originally deposited; how then has the immense volume of materials disappeared, which seems formerly to have occupied those basins in which those lakes, Loughcar and Loughgill, now repose; are we to conclude that the ridges of limestone gravel, found so abundantly in the central plains of Ireland, are the fragments and waste of these calcareous strata broken up and dispersed: the features of this mountain range certainly suggest this impression of their origin rather than the action of an elevating force from below; the beds appear so parallel and unshaken, the joints run so direct and unbroken, for a long distance, in the precipitous escarpments of the limestone rock, that it must discountenance the supposition that any tumultuous movement has taken place beneath them since the first deposition of the strata. That occasional waste has occurred from the effect of land springs washing away the softened slate clay and shale partings, is evident; but this cause is altogether inadequate to account for the disappearance of mountain masses, equal or superior in magnitude to those which remain. That there has been such a disintegration cannot be doubted, it is evidenced by that singular mountain, Knocknarea, which is 1078 feet high, and stands undisturbed, like those pillars reserved in excavations, as a means of calculating the solid contents of materials removed, to ascertain the hire of the workmen; its strata are nearly horizontal, the greater portion of its sides precipitous, and the character of the rock identical with the limestone of Benbulben. The lake of Glencar lies in a basin of limestone, and its south shore is chiefly a precipice, at one place ninety feet high, evidently the remnant of a mass of rock which formerly filled up the hollow now partly occupied by water. The bed of Loughgill and the islands therein are also calca-

reous, while its south bank is skirted by a narrow belt of limestone rising at Doonee Rock to the considerable height of eighty feet perpendicular over the water. Nor is the ruin and dispersion of the strata confined to the north of the Ox mountains, for Knockna Shee, Muckelty, and Caish Corran seem to attest the destruction of surrounding beds of rock; and the caves in the side of the latter mountain have quite the aspect of those ocean caverns which are the haunt of seals and cormorants on the sea coast. The coal formation of Leitrim and Roscommon is placed on the summit of a mountainous elevation, as if it stood the remnant of a more extensive district, once spread widely over those calcareous beds, now scattered and dispersed in the gravel eskers of the central counties of Ireland.

The question now arises, from what influence originated this waste and disintegration? can any existing appearances suggest an adequate cause for changes of such immense magnitude? whether the dikes which traverse the N. W. district of Mayo and Sligo may be memorials of the disturbing force which might have shattered the incumbent strata and prepared them for removal by a diluvial torrent, well deserves to become the subject of farther examination, as already recommended by our President, Mr. Griffith, in his eloquent address of February 1836[a], where he anticipates important conclusions from these investigations, nor do the appearances which form the more immediate subject of this communication seem to me unconnected with this inquiry, for the alteration of the limestone, by contact with mica slate, countenances the possibility that this also may have proceeded from the same reservoir beneath, whence the endless varieties of trap seen in these dikes, with the trachyte and porphyry of Ross[b], have been erupted. I will now conclude, recommending to the amateurs of geology in the N. E. parts of

[a] Dublin Geological Transactions, vol. i. p. 145.

[b] London Geological Transactions, 2nd Series, vol. v. pt. 1, p. 168.

Ireland, a search for the continuations of those dikes, which run such an extended course in the Mayo and Sligo district. The direction of one of these first seen in Erris, strikes our island in the entrance of Carlingford Bay, where a vein of trap is stated to be present, and, crossing the channel, passes over the tunnel of the Huddersfield Canal, where Phillips's Outlines[a] mention the occurrence of a large dike which elevates and intersects the strata; while the bearing of another dike, seen in Erris, intersects the slip or fault in the Leitrim colliery at Altigowlan, as laid down in the map attached to Mr. Griffith's interesting Report. These hints may serve to encourage a careful examination of the intervening country.

Catalogue of Specimens.

M 1.—Mica Slate from the interior of the range at the Rosses.

M 2.—Mica Slate from the vicinity of its junction with the Carlingford limestone.

D 1. 2. 3. 4.—Dolomite from the junction of the limestone and mica slate.

D 5.—Calcspar, same locality.

F 1.—Iron Oxyd, do.

[a] Page 391.

V. *On the Principle of Colouring adopted for the Geological Map of Ireland, and on the Geological Structure of the South of Ireland.* By RICHARD GRIFFITH, Esq., F.G.S.L., and President of the Society.

[June 13, 1839.]

IN presenting to the Society the Geological Map of Ireland on the large scale, the result of my labours for upwards of thirty years, I think it of importance to allude to the principle of colouring which has been followed, and my reasons for adopting that principle.

At the meeting of the British Association for the Advancement of Science in Dublin, I had much conversation on the subject of geological colours with my friends, Mr. Greenough and Mr. Murchison; but nothing of importance as to principle resulted, excepting that Mr. Murchison observed, that in his map of the Silurian Region extending from Shropshire to Pembrokeshire, he intended to colour all his igneous rocks red.

Geologists have long been in the habit of representing granite by a shade of carmine; but trap rocks of all ages have usually been coloured dark olive green. This system was evidently objectionable from its failing to produce a distinctive character on the map between igneous and sedimentary rocks; I therefore determined to reject it, and following out Mr. Murchison's suggestion, to adopt carmine as the characteristic colour for all igneous rocks, and by using different intensities of shade, and also varying the colour by the addition of a little gamboge to the carmine, I have been enabled to produce three shades of red, all transparent colours, which will serve to distinguish granite and syenitic granite from crystalline greenstone and greenstone porphyries, and tabular trap from both; while trap dikes, which

occupy but a small superficies, are represented by orange vermilion, which forms an opaque body colour.

In respect to the sedimentary schistose rocks, I have taken grey as the fundamental colour, making the oldest or mica slate a bright lilac grey, and the greywacke slate a graver tint, having less of carmine, with the addition of some Indian ink. In the newer greywacke or silurian, the carmine is omitted, and a tint of green substituted.

For rocks having a siliceous base, yellow (gamboge) formed the ground work, as in quartz rocks, and the tints representing the several sandstones are formed by adding different shades of brown to the yellow.

The calcareous rocks, with the exception of chalk, are all represented by blues of different shades; but chalk and the green sand which lies below it, owing to their usually occurring in the form of a narrow stripe along the north and east coasts of the county of Antrim, have been represented by a deep green, which serves to distinguish them from the adjoining lias strata, which are also of trifling superficial extent, and which are represented by verditer blue.

The shales of the carboniferous limestone, of the millstone grit, and of the coal formation, are represented by different tints of black; the limestone shales being light bluish black, the millstone grit light yellowish black, and the coal formation black of different degrees of intensity; the deepest representing the localities in which coal is worked or has been discovered.

In those localities where the sedimentary rocks have been altered subsequently to their original deposition by igneous action, and now present a metamorphic character, a wash of carmine has been added to the original shade, which, as in nature, graduates imperceptibly into the usual colour of the rock.

Thus the gneiss of the Ox mountains and other localities of the county of Mayo, which graduates on the one hand

into a stratified granite rock, and on the other into ordinary mica slate, is represented by a reddish purple; and the supposititious mica slate or metamorphic greywacke slate, which occurs along the east and west boundaries of the granite of the county of Wicklow, and also the siliceous schists and semi-porphyries, which occur along the margin of the granite and crystalline greenstone protrusions of the Mourne and Carlingford mountains, are represented by a shade of greyish purple, a colour formed simply by the addition of a light shade of carmine to the original tint of grey.

It is my intention, as soon as leisure permits, to enlarge considerably the condensed outline of the Geology of Ireland, which has been published in the Appendix to the Report of the Irish Railway Commissioners, accompanied by numerous explanatory sections and drawings; but at present it appears to be important to allude shortly to the geological structure of the south of Ireland, as represented on the map, which differs materially from that prepared by Mr. Weaver, and published in the fifth volume, second series, of the Transactions of the Geological Society of London. Mr. Weaver considers the whole of the red clay slate, the dark blackish grey slate, and the limestone of the valleys of the Bride, the Blackwater, the Lee, and Cork Harbour to belong to the transition series, while I have great confidence in considering the red clay slate, and conglomerate, and quartz rock as belonging to the old red sandstone series; and the dark blackish clay slate with its accompanying yellow sandstone, and the succeeding limestone, as belonging to the carboniferous limestone series. The development of the true geological positions of these strata is at this moment a point of considerable geological importance, inasmuch as it not only sets at rest the question with respect to Ireland, but as it tends to throw light on the much contested question concerning the geological position of the strata associated with the cul-

miniferous deposits of Devonshire, which, in many respects, are identical with those of the south of Ireland.

The schistose strata of the counties of Waterford, Cork, and Kerry, which form the base of the entire district, consist of greywacke slate and silurian rocks; but the country has not yet been sufficiently examined in detail, to enable me to determine the exact limits of these formations, which probably graduate insensibly into each other, and in this view the silurian may be considered rather as the upper member of the greywacke than as a distinct series.

Geologists are largely indebted to Mr. Murchison for the publication of his most valuable description of the district already mentioned, which extends from Shropshire to Pembrokeshire, and which he has called the silurian region; to the detailed geological examination of which he devoted the summer months of seven years. Mr. Murchison's elaborate and admirable work, though recently published, is already too well known to require any further notice in this place; I shall merely observe, that I am much indebted to his kind attention in having informed me—from the inspection of some fossils collected by me in the counties of Waterford, Cork, and Kerry, and transmitted to the Geological Society of London—that those from the slate series at Ferriter's Cove, Doonquin, and Foylatarriv, situated at the western extremity of the peninsula of Dingle, in the county Kerry, belong to the lower silurian series. The structure of which locality has already been described by Mr. Charles William Hamilton.

This district had been examined by Mr. Weaver, and by several other geologists previously to Mr. Hamilton's visit, but he was the first who published a section of the strata, and described the difficulties which occur in determining the order of superposition of the schistose strata. Feeling this difficulty, I have again had the locality carefully examined, and at a future period, hope to be able to throw some light on it. At present I shall confine myself to an enumeration

of the silurian fossils, named by Mr. Sowerby, which were among those transmitted by me to London.

Cornulites serpularius,	Ferriter's Cove.
Euomphalus funatus,	ditto.
Terebratula bidentata,	ditto.
Atrypa tenuistriata,	ditto.
Avicula reticulata,	ditto.
retroflexa,	ditto.
Leptæna lata,	ditto.
Terebratula stricklandii,	ditto.
Euomphalus perturbatus?	ditto.

The determination of the geological position of these fossils opens a new field for discovery, and I am of opinion that eventually the greater part, if not the whole of the schistose rocks of the counties of Kerry and Cork, coloured greywacke slate on the map, will prove to be silurian, with the exception of a narrow stripe of black clay slate which extends from the western base of Cahirconree Mountain to Ballinlaggard Bay, east of Dingle Harbour. According to my observations, this stripe forms the lowest part of the slate series, and is probably identical with the black clay slate of Glenpatrick, and other localities of the county of Waterford.

The clay slate of the Dingle Peninsula is succeeded in an unconformable position by beds consisting of coarse-grained conglomerate, which alternate with rather fine-grained indurated red quartzose sandstone, which in some places passes into red quartz rock. The strata dip east at an angle of 10° from the horizon. As we ascend in the series in an eastern direction the conglomerate beds disappear, and they are succeeded by strata consisting of red and reddish brown quartzose sandstone, alternating with coarse red slate, red flag stone, and some green slate. The strata evidently belong to the old red sandstone series, they are succeeded in a conformable position by beds of fine-grained yellowish grey sandstone, being the commencement of the yellow sandstone

of the carboniferous series. This sandstone contains calamites and several obscure casts of bivalve shells, one of which has been named by Mr. Sowerby as the avicula modiolaris?

The upper beds of the yellow sandstone alternate with dark grey clay slate, abounding with casts of fossils, whose distinctive characters are difficult to recognize; but they certainly contain producta, spirifera, terebratula, encrinites, and retepora. Continuing to ascend in the series we find, at Curren's Bridge, beds of carboniferous limestone alternating with the clay slate; at first the slate predominates, but gradually the limestone becomes thick, and the slate diminishes, till at length the latter disappears altogether, and then the whole stratification consists of limestone; the upper beds of the slate assume a greenish grey colour, and are identical with those which occur in a similar position, alternating with carboniferous limestone at the promontory of West Muckruss, at Killarney.

The limestone beds at Currens contain the usual fossils of the carboniferous limestone, the slate also abounds with fossils throughout; but in the latter the shells are usually wanting, and casts alone remain.

From Currens the limestone strata continues uninterruptedly to Castle Island, beyond which they are succeeded in a conformable position by the shales, quartzose sandstones, and culm beds of the great millstone grit series of the counties of Kerry, Cork, Limerick, and Clare, the lower beds of which contain in abundance ammonites, orthoceras, crinoidea, together with spirifera, producta, and possidonia.

In the district of country now above described, within the short distance of about thirty-six miles, we have a suite consisting of the greywacke series, the silurian, the old red sandstone, the carboniferous limestone, and the millstone grit, and on this account it is perhaps one of the best loca-

lities of the south of Ireland in which to study the true relations of the several rocks.

I shall now beg to direct your attention to the south eastern coast of Ireland, where the succession of the strata is similar to that above described; but the apparent position of some portion of the series is in many respects so questionable, that Mr. Weaver, Professor Phillips, and many other geologists have come to the conclusion, that the red and greenish grey clay slate and the limestone which is apparently interstratified with them, belong to the transition series.

Before entering upon the consideration of this subject, it may be desirable to mention that the black and dark grey clay slate of Glenpatrick, Kilmacthomas, &c., of the county of Waterford is succeeded on the south east coast by greenish grey clay slate, usually presenting a metamorphic character. In some places it assumes a porphyritic structure and in others it passes into semi-serpentine; and, occasionally, irregular protrusions of a green chloritic rock are observed, which traverse the metamorphic beds, and frequently present columnar facades.

In the midst of these metamorphic rocks on the shore, at Knockmahon Mines, immediately below the steam engine, some of the beds which still retain their sedimentary character contain numerous fossil remains; the occurrence of which has already been noticed by Mr. Weaver in the paper already alluded to, and also by Mr. Holdsworth, in the first volume of our Journal. Some specimens of the fossils sent from this locality have been recognized by Mr. Murchison as belonging to the lower silurian (caradoc sandstone,) viz., orthis radiatus. Several others sent, have not yet been named by Mr. Sowerby, and if *he* finds a difficulty in doing so, I am sure *I* shall not venture. But since I transmitted the specimens to London, others, particularly some varieties of asaphus, have been collected for me on the

Knockmahon shore by Mr. Ganly; but as they have not yet arrived, I am unable to determine whether or not they are similar to any of those contained in Mr. Murchison's valuable plates.

The identification of silurian fossils on the south east and south coast of Ireland, at the same time, is an important point, and will probably lead to future discoveries. Indeed at my instance some have already been made, but the district has not yet been sufficiently examined to enable me to enter further on the subject at present.

We now come to the main object of this paper, namely, the ascertainment of the true geological positions of the coarse red conglomerate and red slate of Cork and Waterford, of the limestone of Cork Harbour, and of the valleys of the River Lee, Bride, Blackwater, and Suire, as determined by the order of succession, and by the fossil organic remains.

The red conglomerate usually rests unconformably on the grey-wacke slate and silurian series. Commencing with the clay slate which occurs both on the east and west sides of the granite district of Wicklow and Wexford, the first locality in which we find the conglomerate is on the western declivity on the hill of Lyons, from whence it extends in a southern direction to Bishops' Court, in the county of Kildare. Here it is interposed between the greywacke slate and the carboniferous limestone of Ardclogh, &c., without the intervention of any other rock. Red conglomerate occurs in a similar position resting unconformably on slaty quartz rock, and underlying the carboniferous limestone to the north and the south of the town of Wexford, from whence it extends in a southern direction, by Deurcormick, to the sea at Ballyteige Bay; it again appears on the shore of Houseland Bay, interposed between the clay slate, south of Feathard, and the carboniferous limestone of Hookpoint, which has been very accurately described by Mr. Charles William Hamilton, vol. i. page 313 of our Journal. In this locality the conglomerate

crosses the north portion of the peninsula of Hookhead, and enters Waterford Harbour, and appears again on the western coast of the harbour, at Woodstone and Dunmore. There it forms a narrow stripe interposed between the coast and the subjacent greywacke, and from thence it extends in a western direction, parallel to the valley of the River Suire, underlying the carboniferous limestone of that valley in a conformable position. Approaching Clonmel, the southern boundary of the conglomerate, resting unconformably on the greywacke slate of Glenpatrick, bends to the south east, occupies the summits of the Monavullagh mountains, and thence extends without interruption to the sea coast at Ballyvoil Head, south of Stradbally, in the county of Waterford. This conglomerate in the county of Kildare, Wexford, and at Dunmore, &c., in the county of Waterford, has always been considered by Mr. Weaver, Mr. Hamilton, myself, and others, to be the true old red sandstone, but when we examine the country in a southern direction from the summit of the Monavullagh mountains, we find that the conglomerate which forms escarpments, nearly perpendicular, and upwards of five hundred feet in height, is succeeded in the direction of the dip, first by beds of coarse red slate and quartz rock, and afterwards, as we ascend in the series and approach the valley of the River Blackwater near to Lismore, by beds of roofing slate interstratified with quartz rock. It is to be observed, generally, that the roofing slate occurs only in the upper portion of the red slate series. Here then, for the first time, the old red series assumes the character of fissile roofing slate, and it is probable that this unexpected appearance induced Mr. Weaver to suppose that it formed a portion of a series of rocks older than the conglomerate of Monavullagh and Ballyvoil Head, and consequently in his Geological Map of the district he represented the conglomerate of Monavullagh as a mountain cap, resting on greywacke slate. Had he made a careful section of the strata, either from

Monavullagh or Ballyvoil, he would have been convinced of his error, and probably arrived at conclusions similar to mine.

Approaching the Blackwater, the clay slate is succeeded in a conformable position by yellowish-white sandstone and sandstone slate, which in many localities is found to contain casts of calamites, and these strata again are succeeded by the greenish grey imperfect clay slate, which alternates with the limestone of the valley of the River Blackwater; which valley is connected with the carboniferous limestone district of the counties of Cork, Tipperary, &c., and which is admitted by Mr. Weaver to be in connexion with the great carboniferous limestone of Ireland.

The whole of the limestone beds of the river Blackwater at Lismore, dip to the south, but not at equal angles from the horizon; on the north side of the valley, the angle of inclination does not exceed 20°, while in the middle and at the southern side it amounts to 70° or 75°; but still the inclination is to the south.

Proceeding southward from Lismore, at the southern edge of the limestone valley we find greenish grey clay slate and yellowish sandstone, similar to those found on the north side of the valley, but in a reverse order of superposition; they dip to the south at an angle of about 80° from the horizon. Judging from the position of the strata alone, these schistose and arenaceous beds might be supposed to be superior, instead of inferior to the limestone; but arguing from the analogy afforded by other localities in the south of Ireland, there can be no doubt that the limestone and the apparently superincumbent strata incline towards each other in depth and form a synclinal axis.

This fact is frequently observable on the sea coast, and in many precipices and quarries in the interior of the country, and although when seen at the surface the whole of the strata dip towards the south, still these strata present a

series of convolutions, frequently on a small scale, both sides of which incline to the southward, though usually at different angles, and this peculiarity is general throughout the southern counties, and is alike observable in the transition slate, the limestone series, and the culmiferous strata; a circumstance which shews the necessity of extreme caution being used in making calculations as to the probable thickness of any formation, founded solely on the persistence of the strata towards any particular point.

To the south of Lismore, a low ridge intervenes between the valleys of the River Blackwater, and the River Bride at Tullow; this ridge is composed of coarse red slate, and occasionally rather fine-grained greenish grey clay slate; the strata for the most part dip to the south, but in the centre of the ridge they form an anticlinal axis.

Approaching the valley of the Bride at Tullow, we again meet with yellowish white sandstone beds containing calamites similar to those of the valley of the Blackwater, and also greenish grey imperfect slate, which as before is succeeded by limestone; here the calcareous strata form a regular trough, those on the north side dipping to the south, and on the south side to the north; beyond which we have the usual succession of strata, which are interposed between the red schistose beds and the limestone.

The limestone of the valley of the Bride is considered by Mr. Weaver to belong to the transition series; but from its position in respect to the accompanying strata as above described, there can be no doubt that it is similar to the limestone of the Blackwater. Proceeding to the southward, the section extends across the barony of Barrymore, in the county of Cork, to Middleton, and thence in continuation to its southern extremity at Cork Head; within this space a succession of strata similar to that already described is repeated three times: first, we have the red quartzose slate ridge of the barony of Barrymore, succeeded by the yellow

sandstone carboniferous slate and limestone of Middleton; next, the red slate ridge of the Great Island, succeeded by the yellow sandstone carboniferous slate and limestone of Cork Harbour, Carrigaline, &c.; and lastly, the red quartzose ridge of Hoddersfield, which is succeeded, north of Ringabella Creek, by yellow sandstone, greenish grey and dark grey carboniferous slate, which forms so characteristic a feature along the south coast of the county of Cork; this blackish grey slate appears to be similar to the greenish grey slate of the valleys of the Suire, the Blackwater, and the Bride; it underlies the limestone of the valleys of Middleton and of Cork Harbour, where it contains small orthoceras in great abundance, and in both valleys it contains calamites in the lower or sandstone beds. Approaching the limestone of Cork Harbour, at Rostellan, Renniskeddy, &c., the slate assumes a grey colour, is interstratified with limestone, and contains numerous fossils, many of which have been pronounced by Mr. Sowerby to belong to the carboniferous series, while some resemble those which occur underlying the culm measure of Devonshire, which Professor Sedgwick and Mr. Murchison have classed with the old red sandstone of that district.

The fossils named by Mr. Sowerby, which occur also in the carboniferous limestone are:

Spirifer bisulcatus.	Spirifer lineatus.
——— attenuatus.	——— crenistria.
Orthoceras.	——— resupinata.
Plaited terebratula.	——— arachnoidea.
Leptæna lata.	Asaphus gemmuliferus.
Spirifer cuspidatus.	Leptæna depressa.

Besides a variety of casts not named, also of crinoidea and zoophyta.

Similar fossils also occur in the carboniferous slate on the north side of Ringabella Creek at several places, which circumstance, added to the unbroken order observable in the

strata interposed between the red quartzose beds and the limestone of the valleys of all the rivers mentioned, leaves no doubt that the limestone of Cork Harbour, &c., belongs to the carboniferous and not to the transition series.

But to place the matter beyond dispute, within the last three months I have had the principal quarries of the district, examined, and a very large collection of fossils made; duplicates of which have been transmitted by me to the Geological Society of London. The fossils were chiefly collected in the limestone quarries of Little Island, in the river Lee, five miles below Cork; but many are from the limestone and subjacent carboniferous slate of Carrigaline, particularly from Shanbally, Killingley, and Ballinhassig, west of Monkstown, on Cork Harbour, on the north side of the valley, and from Rinniskiddy on the south. The principal univalves were collected in the quarries at Middleton, fourteen miles east of Cork, but still in the same limestone valley in which Cork and Little Island are situate.

Specimens of these fossils are now on the table similar to those transmitted to London, and which have been admitted to belong to the carboniferous limestone, and I shall further observe, that there is not one among them which does not occur in many localities within the great limestone district of Ireland.

In concluding this sketch of the geological structure of the south of Ireland, I have to apologize for the hurried and imperfect manner in which it has been drawn up: but in presenting my large Geological Map of Ireland, I thought it desirable to acquaint the Society with the important discoveries of undoubted silurian fossils in the districts hitherto supposed to belong altogether to an older formation; and also with the fact, amounting to perfect demonstration, that the limestone of the valleys of the counties of Cork and Waterford belongs to the carboniferous and not to the transition series.

VI. *On a new Genus of Entomostraca.* By Frederick M'Coy, Esq.

As the oryctology of the carboniferous series, and particularly of the mountain limestone, has of late years occupied much of the attention of geologists, and as it is only by an attentive examination of the organic remains, that we can ever expect to gain an accurate knowledge of the nature of these interesting deposits, I hope the following observations on "a new fossil genus of Entomostraca," may not prove wholly uninteresting. The fossils of which I compose this *genus*, are from that bed of the mountain limestone usually known as the "Lower Irish Limestone." The geographical locality is Clane, in the county of Kildare. For one of the specimens on the table I am indebted to my friend Professor Scouler; the remainder are from my own cabinet. I might here remark, that there is a figure in "Phillips's Geology of the Mountain Limestone District," which may probably be referred to this species; but there is merely the vague term "a Cypridiform shell" attached, and no other notice either of the figure or of the fossil occurs throughout the work. With the exception of this doubtful and very unsatisfactory synonime, the whole of the entomostraca are new to the formation. As a species and genus new to science, and presenting characters widely different from any other of this most difficult division of the Entomostraca, it will be of nearly equal interest to the geologist and to the zoologist.

Class. *Crustacea.* (Lam.)
Sub-Class. *Entomostraca.* (Leach.)
Division 2nd. *Body covered by a bi-valve shell.* (Leach.)
Sub-Division 2nd. *Head concealed.* (Leach.)
Genus. *Entomoconchus.* (M'Coy.)

Generic Characters. Shell bi-valve, nearly globular; abdominal margin most convex, no sinus; the upper valve greatly overlapping or embracing the under; *two* well-formed beaks on *each* valve near the hinge; hinge terminal, auriculated one-half the length of the shell, situated in the direction of the smallest diameter; surface almost smooth, very finely granular. There exists on the under valve, when the shell is held with its beak from the observer, a small rough oval space near the right hand auriculated appendage of the hinge, in the direction of which its longer diameter points; this roughness is formed of about thirty raised rough waving lines disposed as in the figure; length of this space, three lines, breadth two[a]. Animal unknown; length of the shell from the hinge to the abdominal margin ten lines and a half; greatest breadth eight lines; habitat, mountain limestone. Type of the genus *Entomoconchus Scouleri*, M'Coy. I feel peculiar pleasure in naming this species, the only one of its genus, in honour of my valued friend Dr. Scouler, whose many good qualities and extensive learning must make him equally loved by his friends, and respected by the scientific world at large. The peculiarities of our fossil, on which its rank as a genus depends, are striking and prominent; but its disposition in a natural series is still obscure, from the much to be regretted fact that Leach, Desmarest, and Otho Frids. Müller—the fathers of crustaceology—and who have done so much for the elucidation of the difficult and obscure family at present before us, have almost entirely neglected the characters of the shell in the formation of their genera. This neglect I have endeavoured to repair in the formation of the present genus, which fortunately presents us with extremely well

[a] It has been suggested to me that this was merely the impression of some zoophite which had became attached to it, but I find it constant in the only two specimens of *this valve* which I possess; it is also well developed in Dr. Scouler's specimen.

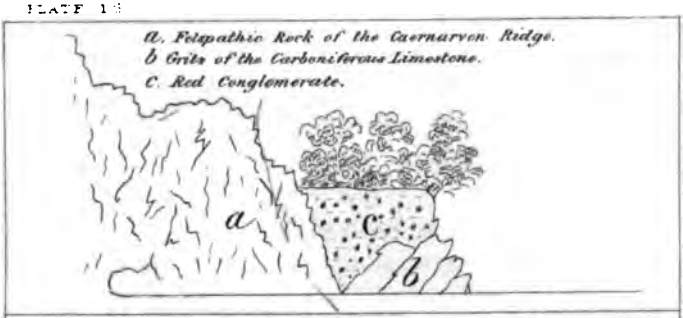
marked and peculiar characters; among the peculiarities of our animal are to be noticed the total absence of the abdominal sinus, so characteristic of the nearly allied genera *Cypris* and *Cytherina*, this part being particularly convex in our genus. But the most remarkable characters, and those on which its distinction as a genus principally depends, are the position of the hinge, and the existence of the auriculated appendages; these characters, as far as my observations extend, are peculiar. In all the bi-valve crustacea with which I am acquainted, the hinge, if I may use the term, is situated in the direction of the *longest* diameter, the shell therefore opens longitudinally; the contrary, however, must have been the case with the present species, the hinge of which is placed at one end, and, as before remarked, in the direction of the *shortest* diameter. In the genus *Lynceus*, indeed, there exists a peculiar process, the *rostrum* of Müller containing the eyes, &c., which, if viewed with the back towards the spectator, *might* be mistaken for the auriculated appendage of this genus; but viewed in any other direction, the illusion vanishes; the rostrum of the genus *Lynceus* is, in fact, a hooked triangular process, terminating for the most part in a sharp point, and curving towards the ventral opening of the shell, to which its base is at right angles; in this species, the appendix is rather square than triangular, consisting of two elongated, oval, flattened tubercles, placed one at each end of the nearly straight line which forms the hinge. *Lynceus* is also a fresh water genus, all the species inhabiting the ponds, lakes, and rivers of Europe. The genera Daphnia and Lynceus having the head formed in this manner, need not be contrasted with this genus, which belongs, as stated above, to the second sub-division of Leach, having *the head concealed;* they are both fresh water genera—this marine. I am not acquainted with any Entomostraca, in which the valves overlap in the manner of the present, which is admirably adapted to afford protection to the inha-

bitant; from an attentive consideration of the hinge, I have been led to the conclusion, that it possessed very limited powers of motion, probably not more than admitted the protrusion and free action of the antennæ and feet; it is very uncommon to find the two valves together, from which I would infer the extremely delicate nature of the hinge, which was probably membraneous. That the animals under consideration were gregarious is, I think, abundantly proved by the specimens on the table, in one of which there are five specimens on a space of little more than one inch. Leach, in writing on the genus *Cytherea*, in Sam. Ent. Compend., says, "All the species inhabit the sea, and may be found among the confervæ and corallines which fill the pools left by the tide on most of the rocky coasts of Europe." That these were also the habits of these animals, I think there can be little doubt, as I have always found them accompanied by numerous species of Retepora, Millepora, Flustra, Calamopora, and such like zoophites, as they love to row among at the present day.

Explanation of the Plate.

A. View of the hinge, and shewing the relative position of the beaks on both valves.
B. Side view, shewing the manner in which the valves overlap.
C. Front view.
D. Natural size.
E. Peculiar marking mentioned at p. 92.

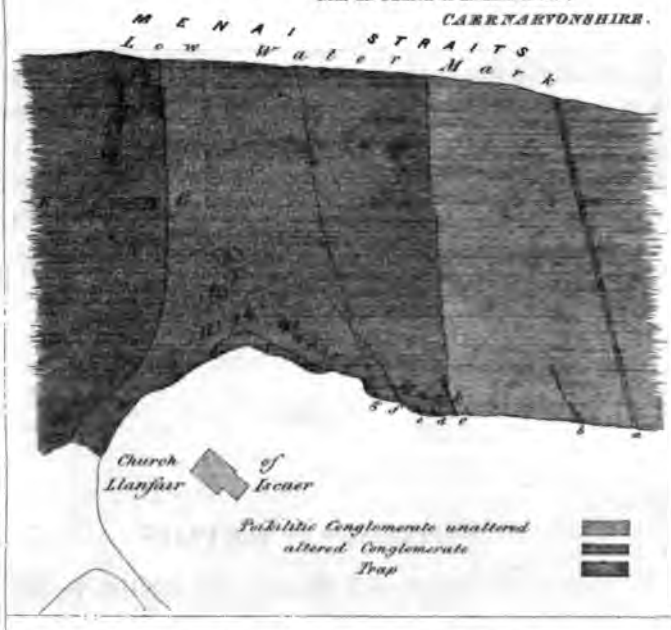
PLATE 1



PLAN OF PART OF THE SHORE OF THE MENAI,
And of the Altered Conglomerate.

Near the Church of Llanfair Iscaer,

CAERNARVONSHIRE.



Section of the Shore of the Menai near the Church of Llanfair Iscaer
Shewing the relative heights of the various portions
of the altered conglomerate.

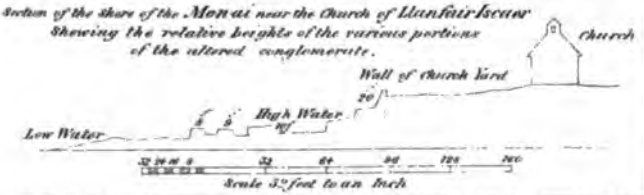


PLATE 2nd

Fig. 1

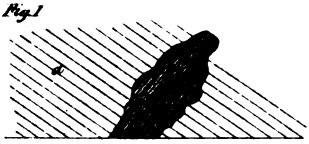


Fig. 2

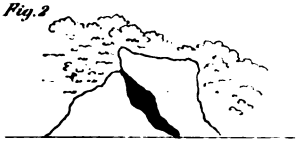


Fig. 3

Carneon a waddy

Trumpet Mt

Fig. 4

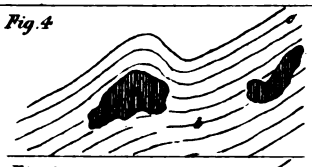


Fig. 5

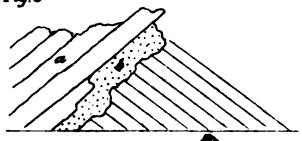


Fig. 6

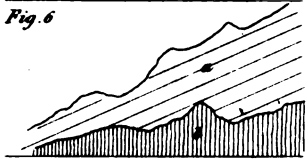


Fig. 7

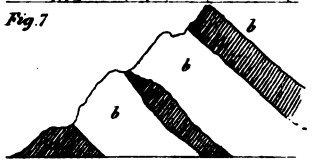


Fig. 8

Fig. 9

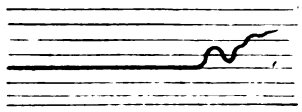


Fig. 10

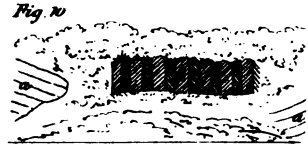


Fig. 11

Fig. 12

Mullochmorn

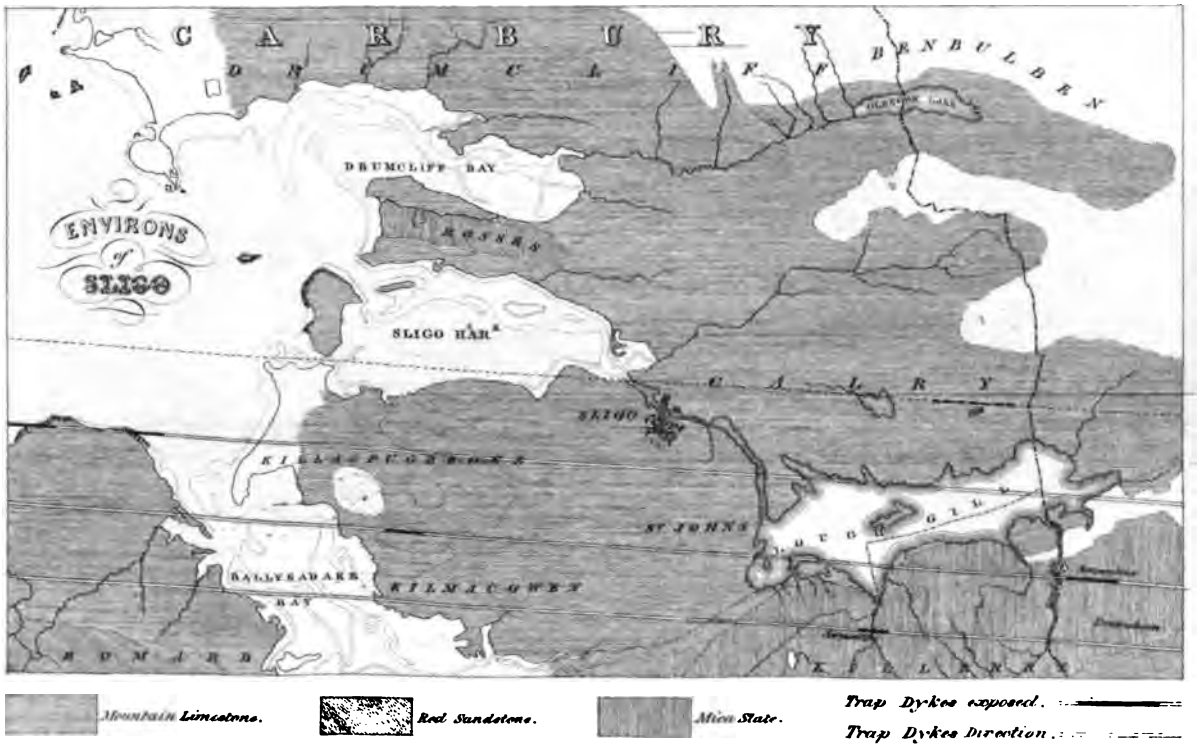
Fore

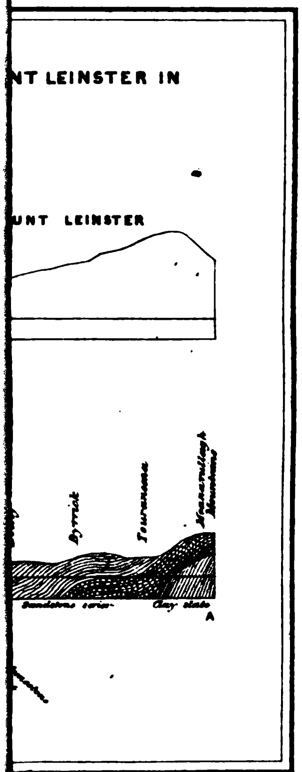
Carrick

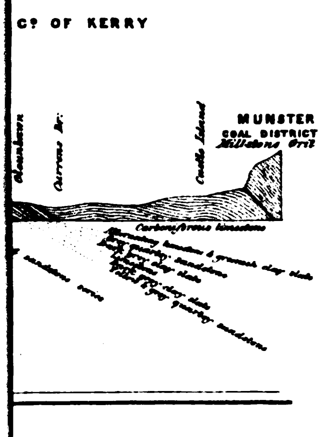
Fig. 13

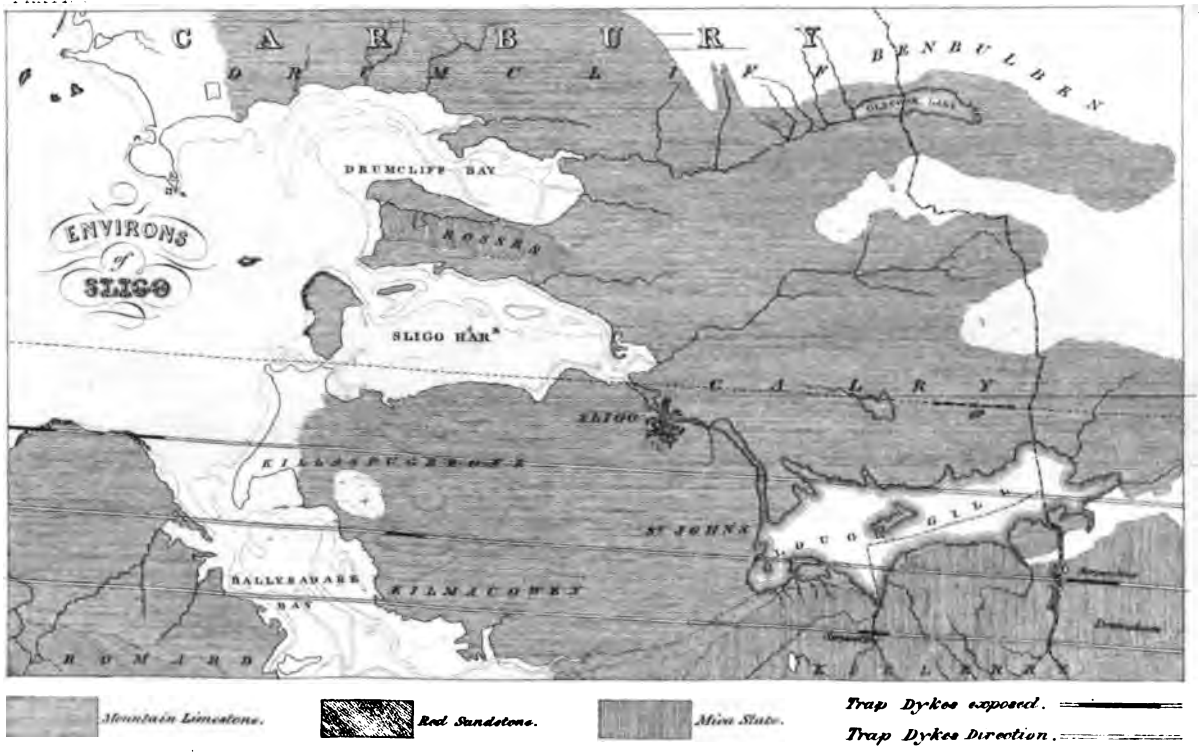
Dunamaise

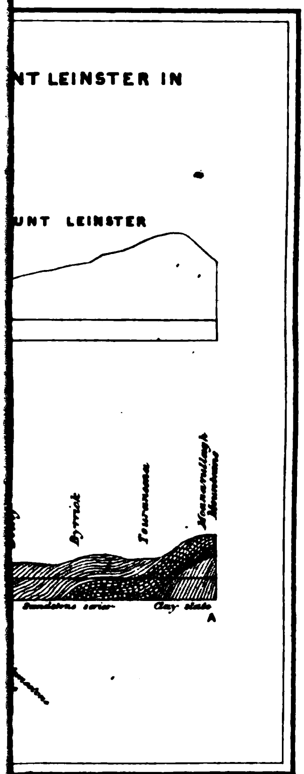
Killone


CARBURY
BENBULBEN
DRUMCLIFF BAY
ENVIRONS of SLIGO
SLIGO HARBR
CALRY
SLIGO
ST JOHNS
BALLYSADARE
KILMACOWEN
BAY
Mountain Limestone.
Red Sandstone.
Mica Slate.
Trap Dykes exposed.
Trap Dykes Direction.


NT LEINSTER IN
UNT LEINSTER
Byrrick
Tournanna
Sandstone series
Clay slate
A


C? OF KERRY
Castle Island
MUNSTER
COAL DISTRICT
Millstone Grit
Carboniferous limestone
sandstone series


CARBURY
DRUMCLIFF BAY
ROSSES
ENVIRONS of SLIGO
SLIGO BAR
SLIGO
ST JOHNS
BALLYSADARE BAY
KILMACOWEN
BENBULBEN
Mountain Limestone.
Red Sandstone.
Mica Slate.
Trap Dykes exposed.
Trap Dykes Direction.


NT LEINSTER IN
UNT LEINSTER
Byrrick
Touranana
Sandstone series
Clay slate
A

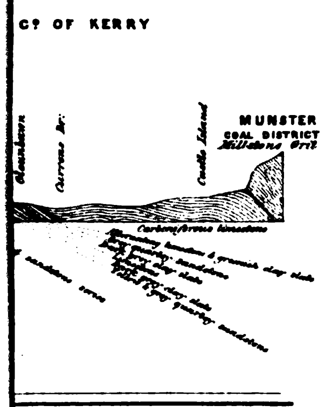
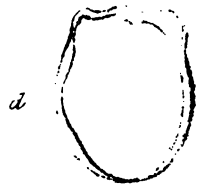

C? OF KERRY
Castle Island
MUNSTER
COAL DISTRICT
Millstone Grit
Carboniferous limestone

PLATE 5.



ENTOMOCONCHUS SCOULERII (*Mc Coy*)

THE ANNUAL REPORT

OF

THE COUNCIL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN,

FOR THE YEAR ENDING FEB. 12TH, 1840.

REPORT.

Your Council, in reporting upon the progress of the Society during the past year, do not deem it necessary to reiterate arguments in favour of the support of such a Society, grounded upon the advantages to be derived by the public from its existence. These they have frequently and strongly put forward; but they would earnestly urge you to inquire into the condition of the Society, to avail yourselves of the advantages offered to the student through means of the arrangement effected in the Museum, and to interest yourselves in collecting facts bearing upon Irish geology, and communicating them to the Society.

Since the last anniversary there have been seven general meetings, at which eight papers have been read, and of these, four were descriptive of the geology of localities in Ireland.

Cases have been purchased sufficient to contain a complete collection of characteristic fossils, and all the specimens already in the Museum have been arranged and named, and are now capable of affording an assistance to the Irish student, which he had hitherto no means of procuring.

A complete set of geological specimens, presented by Lord Cole, have been arranged under glass cases, with their synonyms in English, French, and German, attached.

The principal donations to the Museum have been—

A Collection of Silicified Corals and Woods, from the

West Indies, by Lord Cole, and Sir Philip de Grey Egerton.

A Miscellaneous Collection of Specimens from New Brunswick, by Mr. Gesner, who is employed by Government in making a Geological Survey of that colony.

A Collection of Mineralogical Specimens, from Elba, by Thomas Hutton, Esq.

The following works have been presented to the Society:

The Ordnance Map of Kildare, from Colonel Colby, by direction of his Excellency the Lord Lieutenant.

The Dublin Medical Press, and the Mining Journal, by the Editors.

Your account with the Treasurer leaves the Society £2 6*s*. 4*d*. in debt, but there are outstanding arrears of subscriptions, more than sufficient to cover that sum.

During the past year the following members have joined the Society.

Thomas F. Bergin, Esq.
Leland Crosthwait, Esq.
Daniel Dowling, Esq.
James Duncan, Esq. M.D.
George Evans, Esq. M.P.
Chris. Fleming, Esq. M.D.
The Earl Fitzwilliam.
Lord Fitzgerald and Vesci.
Robert R. Gray, Esq.
Lieut. James, R. E.
James Kerr, Esq.
The Marquis of Lansdowne.
Frederick M'Coy, Esq.
Viscount Morpeth.
Jacob Owen, Esq.
R. P. Williams, Esq.
John Wynne, Esq. (Hazlewood.)
Lieut. Wynne, R. E.
Francis Whitla, Esq.

The first part of a new volume of the Journal of the Society was published in June, and upon comparing the cost of the Journal with the receipts for copies purchased by members during the past years, your Council resolved that it would be for the advantage of the Society to assimilate the Journal to the Proceedings of the Geological Society

of London, and distribute one copy to each member gratuitously.

With respect to the financial prospects of the Society, your Council have only to urge upon you the consideration that it would require the subscription of forty additional members, to preserve the Society in a fully effective state; and while the Geological Society of London already numbers above a thousand members, your Council feel, that when urging upon you the necessity of personal exertion in endeavouring to increase the number of contributors, they are not asking support for any visionary experiment, but for a real and practical mode of advancing the welfare of our country, which has been proved and acknowledged by the landed proprietors of England.

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FOR THE YEAR 1840.

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VICE-PRESIDENTS.

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Richard Griffith, Esq.
Captain Portlock, R.E.
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John Scouler, Esq. M.D.

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James Pim, jun. Esq.
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THUS MARKED * ARE MEMBERS FOR LIFE.

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* Aher, David,
Apjohn, James, M.D., M.R.I.A., Professor of Chemistry, Royal College of Surgeons.
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* Bordes, Captain George, R.E.
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Bruce, Haliday.
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Callwell, Robert.
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Davy, Edmond, M.R.I.A., Professor of Chemistry, Royal Dublin Society.
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Duncan, James, M.D.
Edington, William.
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Fitzgerald and Vesci, Lord.
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Homan, Sir William, Bart.
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Hutton, Thomas, F.G.S.
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Hone, Nathaniel, Jun.
Hogan, William.
Jacob, Arthur, M.D., M.R.I.A.
* Jephson, Sir Charles D., Bart., M.P.
Joy, Henry, M.R.I.A.
James, Lieut., R.E.
* Jackson, James Eyre.
Kane, Robert, M.D., M.R.I.A., Professor of Natural Philosophy. Royal Dublin Society.
* Kearney, Thomas.
* King, Hon. James.
* Kelly, John.
Kerr, James.

Kertland, William J.
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Law, Robert, M.D.
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Litton, Edward.
Lloyd, Rev. Humphrey, F.T.C.D., M.R.I.A.
Lyle, Acheson.
Litton, Samuel, M.D., M.R.I.A.
Longfield, William.
* Lansdowne, Marquis of.
* Lindsay, Henry L.
Leahy, John.
* M'Adam, James.
Mackay, James.
Mac Donnell, John, M.D., M.R.I.A.
Mullins, Bernard.
M'Cullagh, William Torrens.
Mollan, John, M.D.
Mallet, Robert, M.R.I.A.
Morpeth, Viscount.
M'Coy, Frederick.
Mahony, Pierce.
* Montgomery, J. C.
Marsh, Sir Henry, Bart., M.D.
Nicholson, John, A.M., M.B.I.
Nicholls, George.
O'Grady, M., M.D.
O'Grady, Richard J.
Owen, Jacob.
O'Flaherty, Jerome.
Patten, John.
Pigott, D. R., M.P., Solicitor-General.
Pim, James, Jun., M.R.I.A.
Portlock, Captain, R.E., F.G.S., M.R.I.A., F.R.S.
Purdy, Richard.
Pim, Richard.
Perry, James.
Renny, H. L., R.E.
Reilly, John.
Robinson, Thomas Jeffrey.
Radcliffe, John.
Scott, James.
Singer, Rev. J. H., D.D., F.T.C.D., M.R.I.A.
Smith, Aquilla, M.D., M.R.I.A.
* Sadleir, Rev. Franc, D.D., M.R.I.A., Provost T.C.D.
Smith, Rev. G. Sidney.
Smith, George.
Smith, Thomas B.
Staples, Sir Thomas, Bart., LL.D.

Stokes, Whitley, M.D. M.R.I.A., Professor of Natural History, T.C.D.
Scouler, John, M.D., Professor of Mineralogy, Royal Dub. Society.
* Saunderson, Alexander.
Stewart, James Robert.
* Tighe, William F.
Todd, Rev. James, D.D., F.T.C.D., M.R.I.A.
Tomb, George.
* Verschoyle, Archdeacon.
Wall, Rev. Charles W., D.D., S.F.T.C.D.
Wall, James.
Weld, Isaac, M.R.I.A.
Williams, Richard P.
Wynne, John.
Wynne, George, Lieut., R.E.
Whitla, Francis.

JOURNAL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN.

VII. *Address delivered at the Ninth Annual Meeting of the Geological Society.* By RICHARD GRIFFITH, F.G.S.L., F.R.S., and PRESIDENT of the Society.

[12th February, 1840.]

GENTLEMEN,—In addressing you as your President on this our ninth anniversary, I have to regret that circumstances have rendered it desirable that I should have been elected to fill that important office a second time, within the short space of five years, and the more so from my inability, owing to my public situation, to perform the duties which should naturally devolve on the President; namely, a constant attention to, and watchful care over, the business and interests of the Society. But though this may be the duty of the President, other duties devolve on the members at large. You have heard from the Report of the Council what is the state of our finances; it is true we are not in debt, if the sums due to us were paid; but, gentlemen, have we left any thing undone from want of means, that we might and should have done had we the means?—certainly much. We should have enriched our Library with books and maps, and our Museum with minerals and fossils. Should the members of our Society contribute papers, we may not have adequate means to publish them, and if our papers are not published, who will take the trouble to prepare any? Gentlemen, we may draw on a miserable existence, but without additional funds we

cannot do more, and why should we be content with mere existence? Look at the Geological Society of London, with its thousand members, while we have eighty. I would suggest that every member should endeavour, during the present year, to add a new member to the Society. Had we 150 or 200 members we might proceed with vigour: no doubt two hundred geologists are not to be had, but many gentlemen who are not geologists may see, and I am really sure they will see, the great advantage the country must derive from a Society whose main object is to explore and develope its mineral resources. I need say no more on this head, further than to hope that every member will take the hint, and will use his utmost exertions to increase our number, by at least one member, who will unite with us in the important object we have in view.

Having explained the duty of the members, I shall now return to the President. Though necessarily absent from some of your meetings, I have never for one moment lost sight of the great object of our institution, namely the development of the true geological structure of Ireland; a subject which has in a great measure occupied my mind and body for the last thirty years, and towards the solution of which, as far as my labours have gone, I have published my large geological map of this country.

In putting forward this work, I by no means wish it to be understood that the important object for which it was undertaken has been accomplished; far from it, for although I believe that the great outlines of the rock formations are laid down with considerable accuracy as to their boundaries, still, much detail requires to be filled up connected with the boundaries of our smaller igneous protrusions, and metamorphic districts; and also the division of the transition slates from the silurian formations.

In the carboniferous limestone the subdivision of the yellow sandstone, lower limestone, the calp strata, and the upper limestone, are by no means perfect, and I already

possess much information on that head, which I hope soon to be able to bring forward. I allude especially to the boundaries of the great calp district which extends from Dublin through the Counties of Kildare, King's County, Westmeath and Meath; also to the marking out the boundaries of several detached portions, or islands, of the lower limestone, which rise up from beneath the calp, as those of Cloghran, Feltrim, Carrick, Oldtown, and many other localities, together with the boundaries of several detached hills, or small districts, composed of yellow sandstone, which also rise up from beneath the lower limestone, some of which are already known to me, and one which I have not yet examined, situated between Loughowel, in the County of Westmeath, and the yellow sandstone hill of Ardagh, in the County of Longford, has been pointed out by Mr. Charles Hamilton.

I shall now conclude this subject, and proceed at once to the object of the address, and consider the several interesting papers which have been prepared by our members, and read and discussed in the Society during the last year. In the performance of this duty, I shall not follow the order in which each paper was read, but class them according to the subjects treated of.

I shall commence with our Museum, which I am happy to observe has been much improved during the last year, through the active exertion of our secretaries, Doctor Scouler and Mr. C. W. Hamilton, aided by Mr. M'Coy.

At our meeting for December, Doctor Scouler described in a very clear and satisfactory manner, the object we should have in view, in forming a Geological Museum. The materials required are extremely various, comprehending not merely simple minerals and compound rocks, illustrating the mineral composition of the earth's crust, but also organic fossils, by which we trace the physiological history of the organized beings which have successively lived upon its surface. Our Museum, though still in its

infancy, possesses a very good collection of the more important objects comprehended under either department. We have, 1st, a collection of the more important simple minerals, with which it is essential that every geologist should become acquainted. 2nd. A very complete suite, comprehending the various simple and compound rocks. 3rd. A collection of organic fossils, stratigraphically arranged, and accurately named. In this latter department, the task of naming and classifying the specimens has fallen on Mr. M'Coy, who has executed it with great ability and success. The value of our collections is not, however, to be estimated so much by their extent, as by the very important consideration, that the objects are named and classified: each specimen is referred to its appropriate genus, species, and stratigraphical position; and consequently, as a whole, it is far more useful for all scientific purposes, than one of greater extent, which has not been arranged.

Doctor Scouler also mentioned, that for many of the specimens, especially those belonging to the silurian and carboniferous series, we are indebted to the zeal and activity of Mr. Charles Hamilton; and this liberality should be the more noticed, as it is only through the donations of our friends that our collection can ever be materially increased. He likewise observed, that for the specimens of organic fossils from the newer secondary series, we are chiefly indebted to Lord Cole, and that the crag fossils (of which we possess a very good collection) were presented by Doctor Aquilla Smith.

It is truly pleasing to observe Doctor Scouler's and Mr. M'Coy's exertions in classifying and naming the fossils of the carboniferous limestone of Ireland; they have an ample field before them. The number of collectors is much increased! the demand has caused the quarrymen to look for, and preserve the fossils, and in consequence, new genera as well as species, are daily brought to light. The carboniferous limestone is more fully developed in Ireland

than in any other part of Great Britain; and though Professor Phillips has done much, still much remains to be accomplished, before a perfect arrangement of the fossils can be completed. At present we do not know with certainty that any peculiar fossils occur exclusively in any portion of our limestone series. I have given the matter much consideration, but I am not yet certain that even one fossil is peculiar to the upper, the middle, or the lower limestone; indeed, the greater number of the fossils that have hitherto been collected, are from the lower limestone: few have been sought for in the calp, or middle series, and the quarries and escarpments of the upper limestone have not yet been explored in any place with sufficient care. I have myself made a beginning within the last year under favourable circumstances, and when the fossils collected have been examined, I entertain some expectation that many new discoveries will be brought to light, and the total absence of some fossils which are abundant in the lower limestone, may be used at least as a negative proof, that they do not occur in the upper.

Among the new fossils that have been brought under the notice of the Society during the last year, I may here mention a new genus of Entomostraca, from the lower limestone of the Clane quarry, examined by Mr. Frederick M'Coy, which he has very properly named Entomoconchus Scouleri, accompanied by a very clear and accurate description of the fossil, which is already published in our Journal.

Doctor Scouler likewise contributed a paper, descriptive of two varieties of Echini, also from the Clane quarries, which he has named Palechinus sphericus, and Palechinus ellipticus.

And at our last meeting Mr. M'Coy produced a second paper, descriptive of several fossils which appeared to him to be new, the whole of which he discovered in our Museum. As this paper will be inserted in our Journal it will be unnecessary for me to enter into any detail respecting it in

this place: I shall merely note the habitats and the names given to each by Mr. M'Coy:—

1. Dapedius heterodens, (Fish) Lias shale, Whitby.
2. Arcania Leachii, Gault, Kent.
3. Plageostoma intermedium, Cornbrash, Scarborough.
4. Pecten noduliferus, Subappenine.
5. Ceriopora distans, Limestone, Kildare.
6. Spirifer laminosa, Limestone, Hookhead.
7. Paradoxides forcipata a Trilobite.

This is a good beginning, and I have no doubt, from the proved perseverance and zeal of both Doctor Scouler and Mr. M'Coy, it will be followed up, and that within no distant period, Dublin will possess the most extensive and perfect collection extant of the fossils of the carboniferous limestone.

I shall next direct your attention to a most interesting paper prepared by Mr. Robert Mallet on the metallurgy of iron, copper, lead, and tin, accompanied by notes containing the formulæ of the most important products and educts of the operations for obtaining the metals; of these, the crystalline slags are by far the most interesting and instructive to the geologist, some of which would appear to throw a light on the origin of some of our crystalline minerals; and the effect produced by long-continued heat on the white sandstone of which the lower part of our iron furnaces is composed, may tend, in some degree, to illustrate the theory of metamorphic rocks.

The sandstone used consists of a siliceous base, with an argillaceous cement, and this without being actually fused is often converted into a mass resembling greenstone porphyry, in specific gravity, hardness, colour, and general structure, and Mr. Mallet exhibited a specimen taken from the bottom of an old iron furnace at Merthyr Tydville, containing large and perfect crystals of felspar, which much resembled an ordinary metamorphic porphyry. Doubts having been entertained as to the source from whence the alkali contained in

the felspar was obtained, and it having been suggested that it might be derived from matter in the furnace, Mr. Mallet was of opinion that such was the case, and that one of the educts occasionally found in blast furnaces is cyanuret of potassium. (K Cy.)

Mr. Mallet also observed that fire-bricks of Stourbridge clay, after having been long alternately heated and cooled, pass into a dark porphyritic mass, containing milk-white imbedded quartz. In this case the constituents of the original clay, Al + Si, apparently become separated by the combination of the alumine with oxide of iron, and the silex aggregates itself in nodules through the mass, in accordance with that law by which like elements, when diffused through a viscid mass, seek out and unite with particles of their own order. This is strikingly exemplified in the well-known fact that in the "slip kiln" of the potteries, the cream composed of ground flint and Porcelain clay, if let to repose, is soon found to contain hard lumps here and there, which consist almost wholly of silex, which has separated itself from the clay, and begun to indurate.

Iron foundry cupolas are usually bottomed with common damp rabbit sand rammed hard; this is for some months alternately heated and cooled, and at each heating exposed to a pressure of perhaps five feet of fluid cast iron, which is equal to about fifteen pounds per square inch. Being subjected a few weeks to such treatment the sand is found converted, for about two inches in depth, into white sandstone; for two more it has become dove-grey friable sandstone, and beneath, sand unaltered—*no part of it has ever been fused.* When longer exposed, (and perhaps to higher heats,) it is often changed into glassy quartz, for an inch or more in depth, and this is the state to which the sandstone bottoms of the high furnaces are reduced, and in which crystals of Titanium are found; sometimes this artificial q tz assumes a *slaty fracture*, and Mr. Mallet exhibited a s

men of the kind from the Muirkirk Iron Works of Scotland.

Many changes of an interesting kind are exhibited in the progress of the cooling of the educts of the Iron Works. The slags of each process being observed to crystallize when cooled slowly; but if they are cooled by coming in contact with water, they assume the form of pumice, "the cavities of which contain micaceous iron ore."

When fluid slag comes in contact with coal, as is often the case, the cavities are frequently filled with graphite. Mr. Mallet brought forward many other interesting and important facts, showing the analogy frequently exhibited between the products of our furnaces and many igneous and metamorphic rocks. But sufficient has been quoted to point out the great importance of the subject, and to show that metamorphism is not confined to igneous action, but may likewise be produced, as in the case of the slip kilns, by the attraction of particles without the application of heat.

I shall next consider a paper by Archdeacon Verschoyle, on the Development of Dolomite at the Contact of Mica Slate and Limestone at the Peninsula of the Rosses, in the County of Sligo. As this paper has already been printed in our Journal, and as I shall again have occasion to quote from it, it will not be necessary to notice all the points of interest it contains. At present I shall confine my observations to the principal feature, namely, the Dolomite, respecting which Mr. Verschoyle observes, "that the peninsula of the Rosses which forms the northern boundary of the harbour of Sligo, is composed of mica slate, which on the north side, towards Drumcliffe Bay, is covered by carboniferous limestone. The contact of these rocks is best seen by following a lane which skirts the northern boundary of the demesne of Cregg; by this road the observer soon arrives at a shattered façade of calcareous rock, beneath which the junction between it and the mica slate is well displayed. The mica slate

is not perceptibly altered at thepoint of contact, it is rather softer than elsewhere, showing a tendency to decompose, but in others, it presents large prismatic blocks, effecting a rhomboidal form, the vertical points bearing 10° west of north.

The limestone along the line of boundary is considerably altered, shattered, and traversed by veins of calcareous spar, in many places iridescent, bearing the aspect of having been partially calcined. The strata dip to the north at an angle of 50°. At the particular point above alluded to, the colour of the calcareous rock has been altered from its usual bluish grey tint, to a light yellowish brown; its structure has become semi-crystalline, presenting an arenaceous aspect: and the rock has been converted into a dolomite, containing thirty-seven parts of lime in one hundred.

Mr. Verschoyle further observes, from the facts exhibited at the locality under consideration, combined with the similar occurrence of dolomite among the limestone at Ballyshannon, at its junction with mica slate, it may be inferred that the latter rock exerts an influence on its production; and as in the east Pyrenees, the lime and chalk become charged with iron ochre when near the granite, so here, near the contact with the mica slate, the lime-stone contains nests of red oxide of iron, and traces of magnesia.

The observed change in the external aspect, and frequently in the composition of the limestone of all ages, when found in contact with crystalline and semi-crystalline rocks, has been already under the consideration of the Society; and so much light has been thrown on the subject by the valuable communications of Doctor Apjohn, and Doctor Scouler, already printed in our Journal, and ably commented on by Captain Portlock, in his last presidental address, that that it appears to be unnecessary that I should make any additional observations on Mr. Verschoyle's paper.

We shall next proceed to consider a very important paper by our active Secretary, Mr. Charles William Hamilton,

on the Igneous and Metamorphic Districts of the Slieve Gullion and Carlingford mountains in the Counties of Armagh and Louth.

In this paper the theory of igneous metamorphic rocks contained in Keilhau's Gæa Norwegica, is introduced to our notice, and Mr. Hamilton states that he has found a parallel in this country for many of the positions it contains.

As the paper on the Slieve Gullion and Carlingford district has already been printed in our Journal, it will be rarely necessary to make verbal extracts from it; I shall merely state generally, that Mr. Hamilton considers the granites and greenstones of Slieve Gullion, the granites of O'Meath, and the sienitic greenstone of the Carlingford mountains, to be of contemporaneous origin.

Most modern geologists, whether British or foreign, have admitted and described the protrusion of igneous rocks through the sedimentary. We need only look to the diagram contained in Buckland's Bridgewater Treatise, to that in Lyell's Elements of Geology, and to the explanatory section appended to Murchison's Map of the Silurian Region of England and Wales, to see what are their views on the subject, and what has been generally adopted. But as Mr. Hamilton appears to have arrived at opposite conclusions, from facts observed in this country, as a preliminary to the investigation of the subject, it may be desirable to define clearly what I conceive to be the characteristics of *crystalline igneous rocks*, as contra-distinguished from *metamorphic rocks*.

Crystalline igneous rocks consist of such unstratified mineral masses as present a more or less perfectly crystalline structure, and which, from the appearances visible at their contact with sedimentary rocks, induce the conclusion that they were produced at a period subsequent to the sedimentary rocks.

The facts to be adduced in support of this supposition are:

1st. That the ends of the sedimentary beds frequently

terminate abruptly, and abut against the sides of the crystalline rock—the latter fitting accurately into all the indentations of the sedimentary rocks, visible along the line of contact.

2nd. That no gradation or passage of the sedimentary rock into the crystalline is observable; the boundary lines of each, when well exposed to view, being quite clear and definite.

3rd. That near the contact, the crystalline rock frequently contains angular fragments of the sedimentary; and in many cases large crystalline veins are observed to extend from the crystalline into the sedimentary rocks, some of which cut across the strata, while others have insinuated themselves between the beds.

4th. It is to be observed that the angular fragments of the sedimentary rock included in the crystalline, and also the beds at or near the line of contact, present a metamorphic character, the mass of the rock being much more compact and hard than at a distance, and frequently presenting a semi-crystalline structure, and contains crystals of hornblende, felspar, garnet, (red and black,) chiastolite, &c.; but still the original sedimentary arrangement of the rock remains, together with the division into beds, which, in addition to the other characters, serves clearly to distinguish it from the crystalline rock.

The distance to which the metamorphic character of the sedimentary strata may extend, will depend in a great degree on the volume of the protruded rock, and the angle of inclination which its sides make with the surface.

In many cases, the strata surrounding extensive crystalline districts will exhibit a metamorphic character, for a distance of two or three miles beyond the outward edge of the protruded rock, but within that limit, smaller protrusions, as well as numerous veins or dikes, will usually be observed intersecting the metamorphic strata.

The valley extending from Hilltown to Castlewellan and Newcastle, in the County of Down, which is bounded on the north-west and south-east by large granite protrusions, affords one of our best examples of metamorphic rocks of this kind.

In some localities, rocks presenting a metamorphic igneous character are observed at a considerable distance from any decided igneous protrusion. This is the case in several parts of the Counties of Wicklow, Wexford, and Waterford; but if we look to the geological map we will still find the district mentioned bounded on the north-west by the great granite protrusion of Wicklow, Wexford, and Kilkenny; on the south, by the sienite of the barony of Forth, in the County of Wexford; and in the interior, many decided granite protrusions have been observed—as at West Acton, in Wicklow, Croghan-Kinsella mountain, in Wicklow and Wexford, and Camorus Hill, in Wexford; in addition to which there are many smaller protrusions, consisting of greenstone and compact felspar, in both counties, which it is not necessary to particularize at present.

It would therefore appear, according to this view, that metamorphic rocks are clearly to be distinguished from crystalline igneous rocks, and that the metamorphic character observed in the sedimentary beds, has been effected by the action of fused matter in contact with them, which in most cases has been protruded through the surface, and formed our granites, sienites, greenstones, &c.

Though the foregoing observations may be applied generally to all igneous protruded rocks, and particularly to the igneous districts of the east and south-east of Ireland, I think it right to mention that some doubts may be entertained as to whether the crystalline gneiss which occurs on the outward edges of some of our very old granite protrusions, does not graduate into granite. I have noted several examples tending to this conclusion in the County of Donegal, and also

in the Ox mountains of Sligo; but as all the facts necessary for the elucidation of each case have not been observed with the precision and detail requisite, I shall not dwell on the subject at present, but hope to be able to return to it after my next visit to the County of Donegal. I may here, however, allude to an important fact quite in point, described in the commencement of Archdeacon Verschoyle's paper on the Dolomite in contact with mica slate in the County of Sligo, which, as already mentioned, has been printed in our Journal.

Mr. Verschoyle observes, "that in one part of the Mullet, the western extremity of the barony of Erris, in Mayo, mica slate is observed to graduate into gneiss, and gneiss into granite; while in another the granite throws out veins which penetrate the gneiss and mica slate, and ramify through them in various directions. These facts tend to prove, that at the period of the formation of the granite, a large extent of country was exposed, and probably for a long period, to intense heat, that the strata adjoining the perfectly fused matter which on cooling formed granite, were nearly fused and formed gneiss, that those further removed from the focus became mica slate, and that during this process, veins composed of perfectly fused granite were protruded through the gneiss into the mica slate.

This is an important view, inasmuch as it tends to reconcile in a great measure the difference between what may be termed the metamorphic theory in which all igneous rocks are supposed to graduate into sedimentary rocks, and the *prevailing* theory, that the perfectly fused rocks were elevated in an incandescent state, and acted on the strata near the surface, with more or less effect, in proportion to the volume, and to the duration of intense heat in the operating fused mass.

We shall now proceed to the consideration of the facts on which Mr. Hamilton's views are founded. He describes

Slieve Gullion mountain as composed of granitic compounds of quartz, felspar, and hornblende, and rarely mica; the quartz and felspar being white, and the hornblende black, and that the rock varies in colour from light gray to black, according to the proportion of hornblende it contains.

In my opinion this description includes two rocks of distinct characters, each of which belong to different epochs: namely, granite and greenstone. It is true that both occur in Slieve Gullion mountain, but several facts tend to prove that the greenstone belongs to a later period than the granite—at least that of the base of the mountain, which extends from Forkhill to Jonesborough, &c.

Slieve Gullion is one of the most remarkable igneous mountains in Ireland; it presents the form of a truncated cone, whose summit reaches the elevation of 1893* feet. This mountain rises precipitately out of a valley composed of rather coarse-grained granite, which completely surrounds and insulates it from the other mountains.

In ascending from the south side, the granite of the base is succeeded by a very thick band of coarse-grained greenstone, composed of large crystals of black hornblende, and dark gray felspar; at its north-western extremity, this band is six hundred feet in thickness; but at its south-eastern, it may be less than two hundred feet. It is succeeded by a band of grey granite, divided by joints into horizontal tabular masses, similar to that of Slieve Donard; this granite may be about two hundred feet in thickness. Still ascending, we meet with a second band of greenstone similar to the first, but not so coarse-grained; itvaries from 80 to 140 feet in thickness. Above it we find a very thick mass of very fine-grained, light gray granite, which continues to the summit of the mountain, and forms a sloping escarpment, upwards of 600

* Ordnance Survey.

feet in thickness. This upper granite differs from the middle band, in firmness of grain, and in its presenting upright prismatic joints, similar to those of Mallaghboy mountains, south of Carlingford, which I shall have occasion to allude to presently, and which probably belongs to the most recent *period of protruded rocks.*

Having examined Slieve Gullion mountain with care, I have no hesitation in stating that the granites of the base, of the centre, and of the upper region, do not in any case graduate into greenstone; on the contrary, in every point at which the contacts are visible, the line of separation between the rocks is clearly defined, and easily traced.

These clear contacts do not correspond with the character of the portion of the district described by Mr. Hamilton, who states (p. 58) that he could find no abrupt parting between the black, fine-grained rock, and the purely crystalline light-coloured granite; had he examined Slieve Gullion mountain with care, I think he could not have arrived at such a conclusion.

On the whole, I am of opinion that the granite of the base and the middle region of Slieve Gullion mountain is *older* than the greenstone; in proof of which it may be observed, that the lower greenstone contains a very large included mass of granite, which presents a cliff 800 feet in length, and forty feet in height.

I am likewise of opinion that the granite which forms the upper portion of the mountain is newer than the greenstone, inasmuch as that rock near its boundary, with the fine-grained granite, is penetrated by veins of granite, some of which are ten feet in breadth, though generally they are small, and resemble the granite veins which in the Mourne mountains are usually observed to protrude from the granite into the metamorphic slate.

I shall next notice the occurrence of the greenstone dikes which traverse the granite of the neighbourhood of Newry, some of which are noticed in Mr. Hamilton's paper, page 60; I shall quote the passage, as it is important.

"On the road from Newry to Dundalk, on the top of the hill about one quarter of a mile from Newry, a very remarkable dike may be seen traversing the granite; it is about twelve feet wide, carries large masses of granite along with it, and the flat rhomboidal prisms into which it is divided, arrange themselves perpendicularly to the masses of granite, whether included boulders or walls; at this point it appears to run to 30° E. of S.; the same dike may be seen to the north of the road. Further on there is another dike with the same direction, but not above fourteen inches wide; these appear to be a fine-grained mixture of white felspar and hornblende. The dikes which intersect the lime-quarries at Carlingford, are similarly composed. In a district so full of these dikes it is unnecessary to describe more than a few instances. Every limestone quarry in the neighbourhood of Dundalk is traversed by them; in some places we find them in beds of equal thickness, lying between beds of limestone, so that they might pass for interstratified deposits, but where the quarry is sufficiently open, the termination of the sill or apparent bed is in a form indicative of obtrusion. In some quarries, as that to the west of Bellurgan, the trap has burst out in greater masses, the strata of limestone are tossed in every direction, and the limestone itself, in connexion with the trap, becomes granular and semi-crystalline."

Here then we have greenstone dikes admitted by Mr. Hamilton to be obtruded through limestone, actually fusing it at the point of contact; of course those which traverse the granite must be also obtruded, and hence the greenstone of the dikes is of posterior origin to the granite.

We shall now consider the sienitic greenstone of Carling-

ford mountain, classed by Mr. Hamilton with the granite of Slieve Gullion, but which I conceive to belong to the period of the greenstone of that mountain already mentioned.

Carlingford mountain consists of sienitic greenstone; in some places passing into greenstone; the grain is unusually large, and the crystals of hornblende are frequently well developed. On the north-east and south-east declivities the unstratified rock supports metamorphic schistose strata, having a N. W. and S. E. strike, and N. W. dip, angle 80°. Adjoining the greenstone, the structure of the altered slate is nearly obliterated, but the division into beds is still visible; the rock presents a felspathic appearance, and contains much disseminated iron pyrites; receding from the greenstone the rock gradually passes into a hard, flinty slate, striped black and bluish gray, exactly similar to that described in other localities by Mr. Hamilton, as occurring in the vicinity of the granite of the Mourne mountains, in that of Slieve Gullion, and the neighbourhood of Newry, at length as we approach the sea shore, at Carlingford Castle, the rock exhibits the usual appearance of transition or greywacke slate.

Though the metamorphic rock close to its contact with the greenstone presents a felspathic and highly igneous character, still no transition or passage from the one rock into the other can be traced; on the contrary the line of division is as clear and distinct as between limestone and greenstone.

The metamorphic schistose strata, already mentioned, which overlie the greenstone on the southern declivity of the mountain immediately above Carlingford, are traversed by a great number of large-grained greenstone dikes, varying from ten to twenty and thirty feet in breadth, the grain being large in proportion to the dimensions of the dike. These dikes, though not perfectly parallel to each other, have generally a north-west and south-east strike, and dip towards the mountain at an angle of about 10°, and judging from the positions

in which they occur, little doubt can remain that they have been protruded through the slate from the central mass of the mountain. These veins cut through the highly-inclined metamorphic slate, in a direction nearly at right angles to their dip, and the ends of the strata at the contact with the dikes, (both above and below,) are observed to be much more indurated than at a short distance from the contact.

At Carlingford Castle, and along the sea shore to the east of the town, the greywacke slate is but slightly altered; it is also traversed by numerous greenstone dikes, which probably proceed from the same source as those just mentioned. Similar dikes occur in great numbers in the limestone quarries at Carlingford, and traverse the limestone rock, both vertically and horizontally, in the same manner as those described by Mr. Hamilton as occurring in the limestone quarries in the neighbourhood of Dundalk. In the limestone at Millgrange, two miles S. E. of Carlingford, the quantity of intruded greenstone is so great as to constitute one-half the volume of the rock.

I have thought it necessary to enter into this lengthened detail, for the purpose of proving that the great mass of greenstone of Carlingford mountain is of coeval origin with the greenstone dikes which traverse that mountain, and as dikes of similar composition and appearance, as well as huge mountain masses, traverse the granite of the Slieve Gullion district, we are naturally led to the conclusion that the sienitic greenstone of Carlingford mountain, as well as the large-grained greenstones and dikes of the Slieve Gullion mountain, must be considered as igneous protrusions of posterior origin to the granite of Slieve Gullion; Mr. Hamilton supposes, as we have already stated, that both the granite and the greenstone belong to the same period, and have been produced from the fusion of the same slates; if such were the fact we should expect uniformity in the composition of the fused rock, which round the district presents the same

character and composition, and such being the case, how does it happen that similar ingredients fused at Carlingford should produce greenstone, and at Newry granite.

There is still another fact connected with this district, upon which I think it right to make a few observations. It is the occurrence of the granite already alluded to, which appears to be newer than the greenstone of Slieve Gullion, and Carlingford, and which, at its contact with that rock, particularly to the south of Carlingford, penetrates it in the form of great veins, frequently 60 feet broad, and between 200 and 300 yards in length, inclosing in their progress large angular masses of the crystalline greenstone, and near their extremities forking off into various ramifications. In other places the mass of the greenstone is traversed by numerous thin veins of granite, which penetrating the black mass in various directions, present a remarkable reticulated appearance. This newer granite occupies the whole of the valley of Glenmore, to the west of Carlingford mountain, and at its south-eastern extremity comes in contact with the carboniferous limestone, which, particularly at Grange Irish and Rath, it has altered in a most remarkable manner, the colour of the limestone being changed from dark grey to white, the grain being perfectly crystalline, resembling Carrara marble, and containing numerous crystals of garnet. Considering this to be a remarkable example of metamorphism, I transmitted some specimens of the altered limestone to our President, Doctor Apjohn, who has had the kindness to examine them chemically, and has informed me that he finds the specimens to consist of a mixture of very small quantities of granite and limestone, with a compound, apparently formed by the contact of these two rocks at an elevated heat.

When reduced to fine powder, and dissolved almost perfectly in strong muriatic acid, upon evaporation abundant gelatinous silex is developed.

Doctor Apjohn further mentions, that the distinct imbedded crystals contained in the mass appear to be common garnet.

This newer granite is rather fine-grained, and is composed of grey felspar, passing into white; grey quartz, black hornblende, and occasionally a little black mica. Three-fourths of the mass consist of felspar, less than one-fourth is quartz, and a very small proportion of hornblende. Though on the whole, this granite is rather fine-grained, in some localities, particularly at Slievenaglogh, it is coarse, and contains crystals of quartz, and felspar of considerable size.

When seen at a distance the external aspect of the granite of Slievenaglogh differs materially from that of Slievedonard, and the base of Slieve Gullion; the Slievedonard granite presents nearly horizontal tabular masses, while at Slievenaglogh, and other localities in Glenmore, and on the summit of Slieve Gullion the newer granite is divided by upright joints into elongated four-sided prisms of unequal dimensions; in this respect it resembles some varieties of greenstone, but the elongated masses are more flaggy than is usual in greenstones.

The most remarkable granite veins were observed upon the western declivity of Mullaghboy mountain, and extend along the line of junction with the greenstone in a northern direction, as far as the Gap of Barnavave, near Carlingford mountain. In this place the greenstone rock presents the character of greenstone porphyry; it is traversed by numerous granite veins, varying from two to four feet in thickness, and which enclose angular fragments of the greenstone porphyry, some of which are twenty feet in length. Thus it would appear that this district, instead of one, has been the scene of three distinct epochs of igneous action, in two of which the material formed was granite, and the third, greenstone; that in each, the rock produced has been protruded

through the previously existing rocks, whether igneous or sedimentary; that there is no traceable gradation or passage from the sedimentary into the crystalline rocks of any period; and that although considerable alteration has taken place in the appearance and structure of the sedimentary rock in contact with the igneous, and that certain crystalline minerals have been developed in the sedimentary rocks during the successive periods of igneous action, still a precise boundary can be traced between the igneous and the sedimentary rocks, along the line of contact.

There are several other interesting points in Mr. Hamilton's paper, which I should wish to have noticed, had time permitted; but having dwelt so long on the principal subject, I am sure the Society will excuse the omission. I shall only further observe, that Mr. Hamilton's mineralogical descriptions of the rocks are accurate; and though I differ from him respecting the contemporaneous origin of granite and greenstone. I think his sectional sketches are correct, though I have ventured to draw different conclusions from the same premises.

In regard to the numerous dikes represented in mygeological map, as occurring on the east coast of the County of Down, between Newcastle and Kilkeele, Mr. Hamilton is mistaken in supposing them to be 200 or 300 feet in breadth, as with the exception of the porphyry dike, two miles south of Newcastle, which may be about 200 feet broad, these dikes rarely exceed twenty, and in many cases are not more than four feet in breadth.

In addition to his paper on the Slieve Gullion district, Mr. Hamilton has favoured us with a second, descriptive of the geological structure of the island of Lambay, and the opposite coast of the County of Dublin, extending from Rush, by Portrane, to Malahide. The geological relations of this coast, particularly at Portrane, are very obscure, owing to the igneous and metamorphic character of the rocks,

and the numerous heaves and dislocations they have undergone during the period of igneous action; and on this account Mr. Hamilton, in the commencement of his paper, observes, that he brings forward his observations of this district with great diffidence. As far as mineralogical character goes, this district has been already accurately described by Mr. Weaver; but as he made no distinction between unstratified igneous, stratified metamorphic, and ordinary sedimentary rocks, his conclusions differ from those which would naturally be adopted by geologists at the present time. Mr. Weaver considered the island of Lambay, together with the traps, slates, and limestones of the promontory of Portrane, to belong to the transition series, and placed the whole beneath the old red conglomerate of Donabate. Mr. Hamilton, on the contrary, considers the slates and porphyries of Portrane and Lambay to be stratified rocks, *overlying* the old red sandstone of Donabate; that they do not any where exhibit a thickness above a few hundred feet; that they are succeeded by the same alternations of conglomerates, yellow sandstone, and slates, as are found in a similar position throughout the South of Ireland; and that the limestone overlying them at Lambay and Portrane is the true carboniferous limestone.

Here then we find Mr. Weaver and Mr. Hamilton directly at issue, in regard to the relation of the old red sandstone with the slates and limestones of Portrane; and the question to be resolved is, who is right?

The only localities in which the old red conglomerate, and the metamorphic igneous rocks come in contact, are on the north coast of Lambay, the sea shore north of the promontory of Portrane, in the lands of Borough, and in the demesne of Portrane, north of the farm house of Balcarrig, in all of which the old red conglomerate dips to the north-west, and rests on the igneous or metamorphic rock.

Mr. Hamilton, in his section, shews an anticlinal axis in

the conglomerate on the shore at Borough; but having myself examined the rock with much care, I am of opinion that he has mistaken some lines of cleavage visible near the southern extremity of the rock, for lines of stratification; that they are lines of cleavage is proved from similar parallel lines being visible in the fine sandstone stratum situated in the centre of the rock; the occurrence of which, contrasting as it does with the coarse yellow and red conglomerate, proves the true direction of the strike and dip.

Now, if the conglomerate in the three places in which it is visible near the contact with the unstratified rocks, overlies them, we must infer either that it is newer than them, or that the igneous rocks have been projected from beneath, and in their progress elevated the conglomerate rock.

I should describe the peninsula of Portrane as being bounded on the north and south by two large hummocky masses of unstratified rock, each of an elliptical form, half a mile in length, by about one quarter of a mile in breadth, and both exhibiting the same characters and composition.

If we carefully examine the structure of the most northern of these masses, or that which underlies the old red sandstone conglomerate at the strand at Borough, and which extends eastward from thence to the Portrane pier, we will find that it consists of an unstratified, amorphous, semi-crystalline base, having a dark greenish, and sometimes purplish grey colour; no traces of a sedimentary arrangement are visible; and even the strike of the jointage is not persistent in one direction; it varies from north and south to north-west, and occasionally to north-east; and the masses enclosed between the joints present those angular pyramidal forms which so commonly prevail among igneous rocks.

In some places the surface of this unstratified rock includes masses of limestone, which have evidently undergone fusion; the colour varies from white, to reddish white, and brownish red; and the junction with the igneous base is so

perfect on all sides, that it is impossible to separate the rocks in the line of contact. In other places the base of the rock is studded with pea-form nodules of calcareous spar, which gives the appearance of amygdaloid; and adjoining the pier of Portrane, rounded, and sometimes angular fragments of a greenish semi-crystalline rock, having the angles blunted, are included in the base of the rock, which then assumes the character of an igneous breccia.

This rock also occasionally presents the greenish aspect and character of semi-serpentine, which passes into regular greenstone porphyry, having large crystals of greenish white felspar; and the whole is traversed in several directions by thin veins of quartz, and red and white calcareous spar.

On the south side of Portrane pier, we find beds of metamorphic conglomerate, dipping to the south at an angle of about 15°, resting on the unstratified base, and apparently *graduating into it.* This conglomerate is quite distinct in character and composition from the old red conglomerate already described as occurring at Borough, on the north side of the unstratified rock; it consists of a base of slate, and contains rolled masses of various sizes of limestone and quartz, both presenting a fragmentary brecciated structure. The highly metamorphic character of this conglomerate disappears at the distance of about twenty feet to the south from the first bed of conglomerate, which is observed to rest on the unstratified rock: at this point, the slaty base of the conglomerate is soft, and of a smoke-grey colour; and it preserves that character, though it occasionally varies in colour, from grey to black, for a considerable distance to the south.

I have been induced to enter into the foregoing detailed description of rocks adjoining Portrane pier, in consequence of the difference of opinion which exists between Mr. Hamilton and myself, as to whether it should be considered as a protruded igneous or a stratified metamorphic rock, which has been altered in the position in which it now occurs.

Mr. Weaver agrees with me in considering the rock to be unstratified, and describes it as a greenstone; certainly, it hardly deserves that name throughout; but still its character is quite distinct from ordinary metamorphic rocks; and it is certainly more crystalline in its structure than many undoubted protrusions which may be seen on the coasts of the Counties of Donegal, Antrim, Down, Wexford, and Waterford. But the character which induced me to consider these rocks to be protruded, and to mark them as such in my geological map, is the very short space which intervenes on the south side of Portrane pier, between the decidedly igneous and metamorphic character of the conglomerate resting on the unstratified rock, and the unaltered smoke-grey base of the same conglomerate, at the distance of about twenty feet from it. Now, if the rock on which the pier stands were altered by the action of heat *in its present position*, the whole of the neighbouring district must have been exposed to a very high temperature at the same time; and in such case the transition from the highly-indurated metamorphic rock, south of the pier, to the soft smoke-grey base of the conglomerate, could not have taken place in the short distance of twenty feet.

But there is another circumstance connected with this unstratified rock which merits attention, namely, that the line of boundary, though parallel to that of the stratified calcareous conglomerate south of Portrane pier, appears to be quite unconformable with the stratified rocks in other places. The fact of unconformability is most clearly exemplified at the contract of the southern unstratified mass with the schistose beds visible on the sea shore, east of Balcarrig House, and north of the second Martello Tower. In this locality the strata abut obliquely against the external boundary of the unstratified rock, and from a junction as abrupt as those presented by the contacts of the sienitic

greenstone with the metamorphic slate of Carlingford mountain.

Hence we arrive at the conclusion, that the unstratified rocks of Portrane are protruded masses, probably of the nature of serpentine, which should not be classed with ordinary metamorphic rocks.

In regard to the relative positions of the strata whicr occur within the limits of the northern and southen protruded masses, and also in respect to their position in geological precedence, I cannot agree with Mr. Hamilton; but as it would be impossible to clear up so different a case without the aid of detailed maps and sections, I shall not enter upon the subject further than to state that my opinion remains unchanged as to the whole being inferior to the old red sandstone, and that the small district in question contains no strata belonging to the yellow sandstone or carboniferous limestone series. In proof of which I shall mention, that some fossils which I lately transmitted to London, collected from the limestone on the shore below Portrane deer park wall, and which have been examined by Mr. Murchison, and Mr. Londsdale at the Geological Society of London, have been pronounced by them to belong to the upper silurian series; several of the fossils sent were very indistinct, some appeared to be new, but three were recognized, namely Syringopera bifurcata, cyathopillum turbinatum, and the chain coral Catenipora escaroides, which latter is decisive, as it has never been discovered either in the Devonian, or carboniferous systems, and occurs only in the upper silurian; consequently the Portrane peninsula belongs to the upper silurian series.

In addition to the fossils above mentioned, there were several, which, owing to the imperfection of the specimens, could not be clearly recognized; one bears a strong resemblance to Favosites gothlandica also Leptæna depressa?

Atrypa didyma? several new corals together with some imperfect trilobites, one of which, according to Mr. Murchison, resembles Calymene macrophthalma, Brong.

Here then for the first time we find calcareous strata on the east coast of Ireland, containing fossils similar to those which occur in the wenlock limestone of Murchison. This is a very important fact, and may lead to future discoveries.

The section of the strata visible on the coast consist in a descending order—

1st. of a coarse-grained, greenish-grey quartzose slate, about sixty feet in thickness.

2nd. Calcareous conglomerate, of unequal thickness, varying from six to twenty feet.

3rd. Grey subcrystalline limestone which contains the fossils above mentioned, about twenty or thirty feet thick.

4th. Alternating beds of impure dark grey limestone and dark gray slate, in thin beds varying from six to twelve inches in thickness, altogether about thirty feet thick.

At the northern extremity of the peninsula adjoining the igneous rock on which the pier of Portrane has been built, we find the conglomerate rock already mentioned composed of a base of clay slate containing rolled masses of brecciated limestone and brecciated quartz rock, owing to the intrusion of igneous rocks between this conglomerate and the limestone beneath the northern Martello Tower; it is impossible to determine the exact relation between it and the calcareous strata above mentioned; but possibly the conglomerate may belong to the coarse-grained green slate which forms the uppermost member of the series.

I shall now beg to say a few words respecting that part of a paper by Mr. Hamilton, published in the *Philosophical Magazine* of December last, which relates to those districts coloured as transition slate in my large Geological Map, situated to the north of Dublin. Mr. Hamilton observes, "that all those tracts which occur between Dublin and Dundalk,

along the course of the Boyne, and in the hills separating the Counties of Cavan and Meath, have been described as the greywacke or transition series, by Mr. Griffith, Mr. Weaver, and others, are in reality all conformable, and immediately inferior to the mountain limestone, and superior to the old red sandstone, and consequently belong to the Devonian series."

I confess I am here surprised at the view taken by Mr. Hamilton, as one of the facts on which his argument is grounded, namely, that the rocks coloured by me as transition are superior to the old red sandstone, has been correctly stated by himself[a] to be *inferior* to that rock where it occurs near Balriggan mill, north-west of Dundalk, in the County of Louth, in which locality the old red sandstone rests unconformably on the transition slate.

In regard to the second point, namely, that the schistose rocks are succeeded by the limestone in a *conformable position*, I have to observe that such is not the fact, for in the only localities, which, owing to the thick covering of diluvial matter, I have been hitherto enabled to observe the contact of the two rocks, the limestone rests unconformably on the transition state. The localities are, in the river north-east of the Naul, in the County of Dublin; at the southern extremity of the village of Duleek, in the County of Meath; at Oldbridge, on the banks of the Boyne, two miles west of Drogheda, in the County of Louth; at Headfort, near Kells; and at the Rock of Fennor, two miles north of Oldcastle, in the County of Meath.

Fortunately, in addition to those facts, we have another which is quite conclusive, namely, the discovery of fossils belonging to the lower silurian or Caradoc sandstone period, which occur in considerable abundance at Grange-geeth, four miles north of Slane, in the County of Meath. These

[a] See Journal of the Geological Society of Dublin, vol. ii. part i. page 59.

fossils have also been examined by Mr. Murchison and Mr. Lonsdale, and they are of opinion that they belong to the lower silurian, and not to the Devonian period, as supposed by Mr. Hamilton. The principal fossils which have been discovered and recognized are,

Orthis Semicircularis,
„ Virgata,
„ Pecten,
„ Compressa?
Terebratula Tripartita,

also Graptolithus foliaceus, (?) from the black clay slate of the lands of Commons, two miles north-east of Slane.

I have now considered the whole of the papers which have been produced by our members within the last year, with the exception of one by myself, on the Geological Structure of the South of Ireland, which having been already published in our Journal, requires no notice from me: and here I might have concluded this address, had I not thought it necessary to notice very briefly the paper already alluded to by our Secretary, Mr. Charles Hamilton, which has been published in the Philosophical Magazine for December last. This paper contains views which are certainly new, respecting the geological positions of the strata of a large portion of the South of Ireland, which views differ entirely from mine, as set forth in my large Geological Map.

Since the publication of this paper, I have visited and examined with great care the district of the County of Kerry, situated to the south of Castlemaine Bay, treated of by Mr. Hamilton, and the result has been that I feel confident in respect to the accuracy of the geological structure of this district, as represented on the map. Mr. Hamilton's opinions are; first, that the old red sandstone of the Gap of Dunloe, of Mac Gillicuddy's Reeks, and of the Purple and Glena mountains, at Killarney, rest *unconformably* on the transition, or, as he calls it, Cambrian series; second, that

the schistose strata situated to the south of Glena, and extending from thence over Turk and Mangerton mountains to the limestone of the valley of the River Kenmare, rest conformably upon the old red sandstone strata of Glena and Brickeen, and being newer than them, belong to the series of rocks described by Professor Sedgwick, and Mr. Murchison as occurring in Devonshire.

In support of this opinion, Mr. Hamilton has published a section extending from Castlemaine Bay, along the west side of the Gap of Dunloe, to the southern base of M'Gillicuddy's Reeks.

I have also examined the same line of country: but my section differs materially from his in all the important points.

According to my view, if we commence with the strata visible on the west side of the Gap of Dunloe, the first rocks met with at the surface consist of reddish grey quartzose sandstone, belonging to the old red sandstone formation. These are succeeded by a series of thick beds, consisting of coarse-grained conglomerate, composed of rounded pebbles of white quartz, varying in size from two inches to a quarter of an inch in diameter, imbedded in reddish-grey arenaceous base. The conglomerate is succeeded by coarse-grained brownish-red slate, which is occasionally quarried, and used for inferior roofing slate; these strata are followed by a series of beds, consisting of red quartzose sandstone, alternating with coarse slate, the sandstone beds presenting occasionally a conglomeratic character, but the pebbles rarely extend half an inch in diameter. The strata dip to the west, though irregularly, at an average angle of about 10° from the horizon; and consequently in ascending the glen in a southern direction, the cliffs present the outgoing or strike of the beds, which, however, are not horizontal, but exhibit a tortuous arrangement, having frequent undulations from north to south. At Esknabuggerny, a short distance beyond the southern extremity of Coosane Lake,

the old red sandstone strata are cut off by a great north-west and south-east fault, immediately to the south of which, thick beds of green chloritic quartz rock appear at the surface, dipping to the south at an angle of from 30° to 50° from the horizon. These strata probably form the lowest portions of the transition rocks, situated to the south of Castlemaine Bay, as we find the whole series complete in an ascending order from them to the summit of the Reeks.

Mr. Hamilton considers the chloritic quartz rock of the Gap of Dunloe to belong to the transition series, and I am of the same opinion. Commencing, then, from this point of agreement, and proceeding in a south-western direction, we find that the chloritic rocks continue to dip to the south, and present an accumulation of strata, for upwards of 500 feet in thickness, varying little in their composition or character, with the exception of an occasional interstratification of thin beds of green and purplish gray clay slate. These slates are quite distinct in character, as well as in colour and composition, from the coarse red slate of the old red sandstone series, they are in fact identical with the Valentia slates, and bear a strong resemblance in colour, composition, and lithological character, to some of those of North Wales.

Still ascending in the series we find that the colour of the quartz rocks gradually change from green to grey, and at length the mineral chlorite is altogether wanting. The grey quartzose beds are not so thick as those which contain chlorite, they likewise alternate with thin beds of slate, which present a purplish grey colour, without any admixture of green. The gray strata may amount altogether to about 800 feet in thickness. Still continuing to ascend, the same character and alternations are preserved as those last described, but the quartzose beds on a fresh fracture present a slight bloom or tint of red, and the disintegrated surface of the rock exhibits a decidedly reddish hue, which is not

visible lower down. The reddish grey strata alternate as before with purplish grey slate, but as we ascend and approach the summits of the Coomeen peest, or eastern ridge of the reeks, the strata assume a more decidedly red character, till at length they pass into brick or cherry red quartz rock, and contain some beds of conglomerate, identical in colour, composition, and structure with the old red sandstone of the Gap of Dunloe, but not quite so coarse-grained.[a] These red quartoze or old red sandstone beds differ materially from the schistose beds of the lower part of the series. The strata are thinner, and they are divided by joints into rectangular masses, while the schistose beds beneath usually present rhomboidal forms.

The conglomerate on the top of the reeks is perfectly conformable with the underlying strata, and in fact a regular gradation may be traced from the lower, or chloritic portion of the series, through the grey and reddish gray into the brick red quartz rock and conglomerate.

From the summit of the reeks proceeding in a southern direction towards the valley of Kenmare, we do not find these old red sandstone strata dipping to the southward, as shewn on Mr. Hamilton's section, published in the first volume of the Journal of our Society, page 285, but on the contrary they crop out to the southward, forming a regular cap, resting conformably on the inferior strata, whose ends also appear forming a precipitous escarpment, which is visible on the northern side of the valley of Coomyduff, in the bottom of which the green chloritic beds already described as occurring in the Gap of Dunloe, again make their appearance, and the whole succession of the strata, and passage from the green chloritic beds to the red conglomerate, as already described on the northern acclivity of the reeks, may likewise be traced on the southern. To the

[a] The conglomerate visible near the summit of Lisbuy mountain on the western range of the reeks, is fully as coarse grained as that of the Gap of Dunloe.

south of the valley of Coomyduff, the chloritic strata as before are succeeded by the grey, from beneath which the green again emerges in the valley of the river Omreagh, and further south on Cappamore hill they are again succeeded by the grey quartzose rock, which continues from thence towards the valley of Kenmare, where they graduate into reddish-grey as in the reeks, and at length near Lessyclerrick, north of Roughty Bridge, these strata are succeeded in a conformable position by red quartzose rocks of the old red sandstone formation; still ascending in the series, the red strata become more schistose, and chiefly consist of coarse red clay slate, which approaching the limestone of the river Roughty, is observed to alternate with yellowish-green clay slate, and red limestone in thin beds; these are succeeded by strata of yellowish quartzose sandstone containing calamites, the characteristic fossil of the yellow sandstone series; the upper beds of which alternate with greenish grey and dark grey clay slate, with occasional beds of grey limestone; still ascending the limestone gradually predominates till at length the slate disappears, and the whole stratification is composed of carboniferous limestone.

To the south of the river Roughty, in a descending order, a similar series to that above described appears at the surface, dipping to the north, so that we have again the dark grey slate and limestone, the yellow sandstone with calamites, the red limestone, the old red sandstone, consisting of red slate and quartz rock, and in continuation the whole suite of the schistoze strata already described.

I have been thus particular in describing the succession of the strata on account of its differing so materially from Mr. Hamilton's section, and I am decidedly of opinion, that the old red sandstone to the south of Castlemaine Bay, has been deposited conformably on the underlying strata, and that the apparent unconformability, noticed by Mr. Hamilton as occurring in the Gap of Dunloe, arises from a dislocationof the strata, occasioned by a great fault, and not from original deposition.

The great fault just mentioned crosses the Gap of Dunloe, nearly at right angles, and extends from thence in a south-eastern direction along the northern declivities of the Purple, Toomies, and Glena mountains, from whence in continuation it reaches the lower lake of Killarney, near to the cottage banqueting-house of Glena, thence crossing Brickeen Island,' and passing through Turk Lake, reaches to the north base of Turk mountain. This fault may be said to form the key to the geology of the Killarney district, as it explains the apparent anomaly deducible from the persistent dip to the south at Glena cottage, and Brickeen Island, of the strata on both sides of the fault, which might lead, and has led incautious observers to infer that the strata, belonging to the transition slate series which occur to the south of the fault rest *conformably* on top of the old red sandstone of Brickeen Island, Brickeen Bridge, and likewise on the carboniferous limestone east of Turk cottage.

I have already entered into so much detail, that I cannot venture to describe the position and character of the strata visible on the north and south sides of this fault, where it crosses Brickeen Island. It may be sufficient to say that the strata on the north side, whether they consist of old red sandstone, yellow sandstone, or carboniferous limestone abut obliquely against the fault, and have a different strike and dip from the chloritic slate and quartz rock of the south side. The secondary strata of the north side dipping 20° to the east of south at an angle of 30° from the horizon, while the transition of the south dip 12° west of south at an angle of 50°.

I shall only further remark on this subject, that the same succession of strata that have been described as occurring between the chloritic quartzose base up to the old red sandstone of the Reeks, likewise occurs beneath the old red sandstone of the Purple and Glena mountains, and in fact the green chloritic beds of the Gap of Dunloe, described as Cambrian by Mr. Hamilton, may be traced by the line of

their strike along the southern base of the Purple and Glena mountains, to Turk and Mangerton; consequently the chloritic rocks of Glena, Turk and Mangerton, being identical in every respect with the transition strata of Dunloe, must belong to the transition, and not to the Devonian series.

Before I conclude, I must allude to a paragraph in Mr. Hamilton's paper already mentioned, which has been published in the Philosophical Magazine, in which he states, that among other localities, in which the yellow sandstone is laid down on Mr. Griffith's geological map, *in positions in which it does not exist*, he may mention the boundary of the carboniferous limestone on the banks of the River Roughty, in the valley of Kenmare. In reply to this statement, I shall merely observe, that the yellow sandstone does occur at Kilgarvan on the north side of the valley of Kenmare, above Roughty Bridge, in which locality it overlies the red quartz rock, green and red clay slate, and *red limestone*, and underlies the black carboniferous slate, and carboniferous limestone of the valley of the river Roughty, the whole of the strata dipping to the south; again on the south side of the river, immediately to the east of Roughty Bridge, a similar succession of strata is observed dipping to the north. In this locality, the yellow sandstone contains that variety of calamite which is characteristic of the rock, and which is also abundant at Brickeen Island, near Killarney, and in the same geological position, underlying the limestone of the several troughs of the counties of Waterford and Cork. In the carboniferous slate of Roughty Bridge, Retepora membranacea was observed. I shall mention one other locality in which the strata in connexion with the yellow sandstone have been observed in the valley of the river Roughty, namely, at the pier at Kenmare. At low water in this place, grey quartz rock, and black carboniferous slate may be observed dipping to the north under the lower beds of the carboniferous limestone, which are exposed to view in an adjoining quarry. Immediately to the south of

the slate and quartz, no rocks are visible, the strata being concealed by sand; but within a very short distance, beds of yellowish green slate, alternating with red slate, and red limestone occur, which are identical with the strata visible in the localities already mentioned, underlying the yellow sandstone; no doubt can therefore be entertained that this rock is continuous on the south side of the valley from Kenmare pier to Roughty Bridge.

It is true in the valley of Kenmare, as well as in most others, that the yellow sandstone has not been seen at the surface, throughout the entire length of the carboniferous limestone trough, as owing to a thick covering of diluvial matter or of bog, the precise boundary between the base of the limestone series, and the old red sandstone rocks, is rarely visible; but as the yellow sandstone and dark-grey carboniferous slate do occur in every place where the outer boundary of the limestone series is exposed to view, I feel no doubt that these equally occur in those positions where they are concealed from our view. If geologists were only to mark the limits of their rock districts in the precise localities in which the contacts are visible, no geological map could be formed. In maps on a large scale, the observed contacts might be shewn by continuous, and the supposed by dotted lines; but on a general map, though desirable, it would be nearly impossible to enter into such detail; or, if attempted, it would be impossible on a map on which the features of the country are shewn, to distinguish between the continuous and the dotted lines.

I feel I have an apology to make to the Society for having entered in an Address from this chair into so much detail—I might almost say controversy;—but it must be recollected, that as the author of the Geological Map of Ireland, which has now become public property, it becomes my duty to defend the boundaries of our rock districts, as well as the relative positions of the rocks themselves, from all inroads.

THE ANNUAL REPORT

OF

THE COUNCIL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN,

FOR THE YEAR ENDING FEB. 10TH, 1841.

These fossils, as represented in his drawings, are of extraordinary size, several of them reaching two feet in length. Some he considers as zoophytes, allied to living medusæ, and others as coral zoophytes of an unknown species.

Now, as respects these drawings of Major Austen's, having myself but a very general acquaintance with the subject of fossils, I have thought it right to consult a friend who has made palæontology his especial study; and I cannot do better than introduce here the letter which I have received from him on the subject:

"I have re-examined Major Austen's clay-slate fossils, but do not think that any of the drawings indicate the presence of organized bodies, with the exception of figure, in which some of the bodies, as drawings at least, have a great resemblance to cephalopodous mollusca, resembling ammonites; but as these are not found in the older fossiliferous rocks, if they be shells at all, it is probable that they belong to the genera clymene, or goniatites; but no traces of the edge of the septa being visible, the genus is not easily made out. Figures 1, 2, and 3 are referred by Major Austen to zoophytes, allied to the living medusa. Although they may have some resemblance in general form to some of the acalephæ; yet, when we consider that a medusa weighing thirty pounds, will, when dried, yield but a few grains of solid matter, I think we can hardly ever expect to find those animals in the fossil state. The remaining sketches are considered by Major Austen to represent coral zoophytes of an unknown species. I have quite failed in any attempt to refer them to any genus of corals living, or fossil; and I might almost hazard an opinion, that they do not belong to that class; at least, I see no point of structure or general reremblance to warrant the conclusion. Some of them certainly appear to be *sui generis;* and 3 and 6 remind one rather of certain plants than of coral zoophytes."

Throughout the remainder of his paper, it is Major Aus-

ten's object to shew, that "the estuary and bed of the river Suire, as far inland as Waterford, present indications of having been formed by a succession of volcanoes, and volcanic rents."

In support of this opinion a variety of interesting and apposite facts are adduced. Thus, near the mouth of the estuary at Hervyloch, there is a large block of lava protruding through the surface; and from this place to Bluff Head along the beach, considerable quantities of amygdaloid and greenstone are every where met with, which he regards as undoubted evidence of volcanic proximity. Duncannon Fort is built upon an igneous rock, which rests unconformably on the edges of the uplifted and ruptured schist. At Cheek Point a mass of lava, or trap, juts out from beneath the conglomerate, which overlies it; and higher up on the little island and the opposite shore, the clay-slate strata have been altered into hornblende schist, and forced into nearly a vertical position. Lastly, the limestone of Hookhead is said to be magnesian, a change which, as is well known, Von Buch refers to the vicinity of igneous action; while the bottom of the King's Channel is described to be so uneven, and its banks so steep, as strongly to corroborate the hypothesis which he advocates.

This latter part of Major Austen's communication is probably the most valuable, not because of the speculations, but of the facts it contains. Several of these are new; for Mr. Griffith exhibits no igneous protrusion throughout this entire district; nor have such been noticed by Mr. Hamilton by whom it has also been visited. I may add, that this latter geologist, who has published an able paper in Vol. I., Part 4, of our Journal, on the subject of the limestone of Hookhead, nowhere describes it as magnesian.

At our Meeting in May, a paper was communicated by Archdeacon Verschoyle "On a spheroidal Concretion in Sandstone, at Bundoran, County Donegal."

This concretion, which was illustrated by a drawing, is described as presenting itself in the face of a cliff of moderate height, constituting, at high-water mark, the shore below Bundoran, a little village situate on the southern side of the Bay of Donegal, and within a short distance of Ballyshannon. The strata of which the coast is here composed, are sandstone and shale in successive layers, belonging, apparently, to the lower portions of the carboniferous limestone formation; and the concretion which is the subject of Archdeacon Verschoyle's communication, is found in a bed of the arenaceous rock, inclosed between two beds of shale. In appearance it resembles a water-worn stone taken from the sea beach, is about five and a-half feet in length, and above two feet in thickness; rather less than that of the sandstone bed of which it forms a part, the external layers of which, and the shale beneath, curve downward as if depressed by its weight. It is identical in colour, fracture, and character, with the surrounding stratum; and the rhomboidal structure appearing in its fracture, coincides in direction with that of the surrounding rock.

From these circumstances, Archdeacon Verschoyle rejects the idea which first suggested itself, in reference to the origin of this and some other smaller spheroidal masses occurring in the same locality, viz., that they were imbedded water-worn boulders; and adopts as more probable the view, that carburetted hydrogen gas disengaged from the shale, formed in the sandstone, before its induration, cavities of a globular form, and that by the absorption, or escape of the gas, these came to be subsequently filled with sand, the concretion of which gave rise to masses of the same form; and, in consequence of the shrinking which must have taken place before it hardened, having a distinct line, or rather interval of separation between them and the general mass of the surrounding sandstone.

To this theory it might, I think, be objected, that the gas

should have blown cavities in the shale as well as in the sandstone; unless we suppose, and such would, I think, be a gratuitous assumption, that the gas was not disengaged until the shale was solidified, and that after the induration of the shale, the sandstone continued in the pasty state. I may also observe, that if the gas proceeded, as Archdeacon Verschoyle conceives, from the action of water on iron pyrites, it would be sulphuretted not carburetted hydrogen; and as neither of these gases contain oxygen, but have both a strong affinity for it, the oxydized state of the circumference of the cavity noticed by him, would scarcely admit of the explanation which he has given.

In a subsequent part of his paper, Archdeacon Verschoyle touches upon a subject of much greater importance, viz., the geological structure of the neighbourhood of Bundoran.

The alternating beds of sandstone and shale, already described, dip inland to the south east, and rest upon a bed of limestone which comes to the surface on the shore below the village; and is very interesting and remarkable from the unusual perfection, and high state of preservation of its organic remains, consisting almost entirely of the nave encrinite of Parkinson, mixed with the spirifer attenuatus. Following these strata in the direction of their dip, we find them again succeeded by overlying beds of sandstone, the out-crop of which presents a terrace rising suddenly about a mile inland, and thence forming an elevated plain reaching to the foot of the mountain range, which extends from Lough Melven to Glencar. In Mr. Griffith's geological map these strata are represented as composed of yellow sandstone, a rock occurring at the lower part of the carboniferous series; but Archdeacon Verschoyle, though provisionally adopting this opinion, does not, by any means, consider it as completely proved, as is obvious from the following passage extracted from his paper: "There may, however, be a doubt whether a conglomerate found at their (the mountains

mentioned above) base, is merely a local variety in the composition of the yellow rock (yellow sandstone) mentioned above, or the old red sandstone intervening between it and the mountain limestone; this I had not an opportunity of ascertaining, but it well deserves investigation, as, in the latter case, the Bundoran strata ought, perhaps, to be arranged in the silurian division."

The view here thrown out is certainly deserving of consideration, the more particularly since, in many other localities, as shall be presently seen, a rock, which is nothing but old conglomerate, has been confounded by Mr. Griffith with his yellow sandstone.

On the same evening, (May 13th,) our Secretary, Mr. C. W. Hamilton, made an oral but very interesting communication to the Society on the subject of the disposition of the materials in gravel pits, as observed by him in the counties of Carlow and Kilkenny. A number of sections were exhibited, which gave very abundant evidence of a slow stratification, accompanied by almost all the appearances which are seen in the older sedimentary rocks, such as diagonal lamination, the thinning out of some of the beds, and veins filled with finer materials intersecting several of the coarser strata. The subject thus practically investigated by Mr. Hamilton has acquired a great interest since the recent researches of Professor Agassiz, researches which have led him to conclude, that the ridges of debris, which occur in many places at the foot of the Alps, and which are usually known under the name of moraines, have been formed and brought to their present position by the action of glaciers. This ingenious theory is certainly not so extensively applicable as some of its advocates would lead one to suppose; and I feel no difficulty in concurring with Mr. Hamilton, that the gravel hills of Ireland, including the escars, have not had such an origin; but are referred, with a much higher degree of probability, to a great wave, or rush of water, which

there are many reasons for believing to have swept over our island in a direction from N. W. to S. E. I may observe, that in a paper recently read at the Royal Irish Academy, by the Rev. Dr. Porter, similar views were very ably and eloquently enforced.

I may here notice two other matters brought verbally before us at subsequent meetings by Mr. Hamilton, and which are highly important, as corrections of received geological facts. The first refers to the Rockabill Islands, or *Cow and Calf*, about eight miles from Balbriggan. These are represented by Mr. Weaver as transition schist; but, upon visiting them recently, Mr. Hamilton found them to consist altogether of granite. This granite also, it is important to notice, is of the micaceous kind, which constitutes the chain of the Dublin and Wicklow mountains, not the syenitic variety found due north in the Mourne range of the county of Down.

His second correction was announced by Mr. Hamilton at our last Monthly Meeting. Upon visiting the hill of Carrickbyrne, in the county of Wexford, which is coloured by Mr. Griffith as consisting of clay-slate and erupted trap to the east, and of granite on the west; he could find neither the erupted trap nor the granite, nor a trace of any rock which could be designated by this latter term, with whatever latitude of signification it might be used, with the exception of a few scattered granite boulders.

The hill-rocks, which are every where well expressed, were found by him to consist of quartzose slate passing into feldspathic slate by insensible degrees, traces of hornblende being visible in some of the latter variety of schist. The nearest approach to granite which he encountered was a syenite, which appears a few hundred yards to the east of Ballibanole Cross, between it and Cushenstown, as exhibited on the Ordnance Map. Matter of fact notices of this description are, in the present state of the geology of Ireland, of the utmost value. Independent of the positive additions they

make to our geological information, they shew the danger of being altogether governed by authority in matters of science, and render it probable, that an accurate revision of the stratification, of even the best explored districts, would lead to new and important results.*

At our last Meeting, a paper was read by Mr. John M'Arthur, on the subject of an ochre found by him at Drumrankin, near Ballymena, in the county of Antrim, on the estate of Earl O'Neill.

A shaft having been sunk in this locality, it was found to have traversed a succession of beds of the tabular trap of the district, the uppermost of which were in a crumbling state; but the rock augmented in consistency and hardness with the depth, so that to prosecute the work it became necessary to blast it. At the distance of thirty feet from the surface, the red clay, or ochre, was encountered, but the boring was discontinued when twelve feet of this deposit were passed through, so that its actual thickness was not determined.

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* In relation to this passage, I would solicit the attention of the reader to the following letter, which I have received from Mr. Hamilton :—

" 37, *Dominick-street, Feb. 20th.*

" My dear Sir,

" I am sorry to find that Mr. Griffith complains of your having put forward my description of Carrickburn as a correction of his map.

" The only point in my description which he finds fault with is, that I should have represented the N. W. side as coloured granite in his map. Now that he points it out, I see that his intention was to represent it as metamorphic slate; and am sorry that I should have been led into error by the indistinctness of the colouring in my copy of the map, which was the first I could procure from Mr. Gardner, and which I did not get until August, 1839. In further justification, or rather explanation, of my error, I may say that Mr. Weaver, Geol. Trans. vol. v. p. 1, p. 183, says, ' The granite base breaks out again in Carrickburn and Camorus Hills.' I may add, that having applied to Messrs. Hodges and Smith to inform me what rock was represented in the instructions given to them by Mr. Griffith, the answer was, ' we read it granite.'

" Yours faithfully,

" CHARLES W. HAMILTON.

" *James Apjohn, Esq., M.D., &c.*"

It is not necessary to follow Mr. M'Arthur through his speculations as to the origin of this deposit. It is, of course, the result of the decomposition of the igneous rock, and of the oxidation of the iron in which it abounds, the oxygen producing this effect being, in all probability, that of the air of the water, which, according to Mr. M'Arthur's detailed description, was found flowing between the strata at different levels. A similar ochre occurs in many other parts of Antrim, always in association with the trap, and no doubt produced by similar causes. The Drumrankin ochre has been analyzed, and found to have the following composition :

Silex, ...	56·40
Alumina, ...	3·46
Perox. Iron, ...	24·14
Carb. Lime, ...	0·90
Water, ...	15·10
	100

The silex of this ochre is present in a state of extreme division, and from this circumstance, and the great depth and beauty of its colour, it appears well suited to the purposes of a red paint for gates, railings, and other descriptions of out-door work.

Such, Gentlemen, are the geological papers which we have had before us since our last anniversary meeting. Other communications, however, have been made to us of a less pretending, but, to many, at least, not less interesting nature, relating to the kindred sciences of mineralogy and organic remains, and to these I shall now draw your attention, with the view of completing my *resumé* of our proceedings for the past year.

The first matter falling under these heads which I find upon my list, is a short paper by myself, relative to a new ore of sulphur, lead, and antimony, found at Kilbricken,

county of Clare, and forwarded to me, through our Vice-President, Mr. T. Hutton, by Mr. M. Taylor, the gentleman who conducts the mining operations in this district, and who published a brief but interesting account of the mines of Clare, in a recent number of our Journal.

As an account of this ore has been published elsewhere, I shall only say that its formula is

$$6\,(S, Pb) + S_3, Sb.$$

or that it contains six atoms of sulphuret of lead, associated with one atom of the tersulphuret of antimony. Its composition in one hundred parts is :—

Sulphur	16·36
Lead	68·87
Antimony	14·39
Iron	0.38
	100

There are many other known native compounds of the same elements, such as zinkenite, plagionite, jamesonite, feather ore of lead, and boulangerite ; but the composition of all these is different from that of the mineral I have described. To kilbrickenite, however, the name which I have given this ore, we have a perfect parallel in the sprödglaserz of Mohs and Werner, which differs from the Irish ore merely in containing silver instead of lead.

At the meeting of our Society, held on the 10th of June, Mr. Mallet brought under our notice the very curious fact of the apparently spontaneous production, *via humida*, of a substance, which would appear to possess the composition and properties of lapis lazuli ; the rare mineral from which is prepared the very beautiful and costly pigment known under the name of ultramarine.

This substance was found adhering to certain granite stones in the neighbourhood of the Hibernian Gas Company's

station, Grand Canal Docks, which he stated to have been in contact with moisture, cast iron, and much carbonaceous matter, and to have been long exposed to the vapour of water and to sulphureous and ammoniacal exhalations evolved in the manufacture of coal gas. Upon making a chemical examination of this substance, Mr. Mallet found it to consist of silex, alumina, soda, sulphur, lime, iron, and carbon; so that the two latter, being excepted, its constituents are the same with those of lapis lazuli, as determined by the analysis of Leopold Gmelin.

I may here observe, as was indeed stated by Mr. Mallet that ultramarine has, upon several occasions, been noticed as an incidental product of processes conducted at a high heat. But the instance just detailed, and it is this which give it its chief mineralogical interest, is, I believe, the only one yet recorded in which it would seem to have been produced at ordinary temperatures, and in the humid way. The verification of this fact by direct experiment would be highly important, as it might lead to an economical process for the manufacture of ultramarine. It would also be interesting under a geological point of view, as illustrating the resources of nature, and rendering it probable that many rocks and minerals may have a double origin, or be produced sometimes by igneous and sometimes by aqueous agency.

On the same evening Mr. Mallet exhibited a specimen of a peculiar substance, found by Archdeacon Vignoles in a bog in the County Kildare, making, at the same time, some remarks upon it. He described it as a soft, moist, and elastic substance, of much the same consistence as the compound of which printers' ink-rollers are made. Its colour was a dark brown, and it was interspersed with veins of marl, close to which at the base of the bog it was found, occurring in detached masses in the midst of a fibrous peat.

From peat Mr. Mallet finds this substance, well distin-

guished by its relation to the fixed and volatile alkalies, in neither of which does it dissolve, except with great difficulty and slowness. Its relations with other chemical agents indicated a substance differing from any of the products of the action of the alkalies on peat, and even suggested some analogies between it and the bitumens; and he inclined, on the whole, to the opinion, that it is a substance intermediate in its nature between fully formed peat and bituminous coal.

It is not here necessary to remind the Society how numerous are the substances into which vegetables have been metamorphosed within the great laboratory of the earth, nor what an important branch of geological science their study constitutes. I may, however, mention, in connexion with Mr. Mallet's communication, that in the course of the past session I exhibited to the Society a specimen of turf, sent me by a friend from a bog near Ramelton, county of Donegal, which was perfect peat at one end, and bituminous coal at the other.

At our Meeting in April, Doctor A. Smith read a short notice, on the occurrence of indicolite, or blue tourmaline, in the county of Donegal.

This mineral, of which a specimen was exhibited, was imbedded in a fine grained granite, containing but a very small proportion of quartz or mica. By its colour, degree of hardness, crystalline form, and pyrognostic characters, all of which were minutely detailed by Doctor Smith, he conceives it completely distinguished from every other known substance.

The analysis of the tourmalines is one of considerable difficulty; and our knowledge of their composition is, therefore, very imperfect, and, I make no doubt, that some minerals, considered as varieties of the tourmaline, are altogether distinct from it. On this account every accurate attempt at distinction is important; and it is under this point of view that I consider Doctor Smith's notice entitled to the attention of mineralo-

gists. Dr. Smith has not determined quantitatively the composition of his specimen; but he conceives it represented by an analysis, which he quotes by Arfwedson. I may observe, however, that (according to Dr. Thompson) the mineral analyzed by this eminent chemist was *green*, not *blue* tourmaline, and that he enumerates amongst its constituents lithia, boracic acid, and water, none of which could be detected by Dr. Smith. But, as I have already hinted, this interesting family of minerals requires a thorough investigation and revision.

At a subsequent Meeting, that held in December, Dr. Smith favoured us with another notice, which cannot fail to fix the attention of the mineralogist and miner, viz., on the occurrence of tin-stone at Croghan Kinshela mountain, in the county of Wicklow.

Having examined carefully a quantity of sand, sent him from the gold works at present carrying on in this locality, he found in it the tin-stone associated with minute grains of native gold, and with several other minerals, such as magnetic iron ore, in small but brilliant octohedrons, fine-grained specular iron ore, and numerous small dodecahedral garnets of a pale red colour.

The existence of the native oxide of tin in Ireland, Dr. Smith admits, was first recorded in 1801, in the report upon the Wicklow gold mines, addressed to the Dublin Society by the Messrs. Mills, Weaver, and King; and was subsequently alluded to by Sir Charles Giesecke in his catalogue of Irish minerals. But no specimen of Irish tin-stone is to be found in any public collection in this city; nor is any mention of such made in the catalogues of the museum of Trinity College published in 1807 and 1813; so that the fact of its occurrence in Ireland has been very generally questioned. Dr. Smith, therefore, must be considered as entitled to the credit of removing all doubt as to a point long disputed, and

equally interesting to the Irish capitalist and the man of science.

I shall conclude this summary of our scientific proceedings by drawing attention to some notices on the subject of organic remains, brought forward at two or three of the monthly meetings by our zealous and intelligent member, Mr. Frederick M'Coy.

His first communication relates to some Australian fossils, collected in the vicinity of Hobartstown, Van Diemen's Land, and belonging to genera, such as isocardia, sanguinolaria, spirifer, atrypa, and leptæna, highly characteristic of our mountain limestone. Specimens of these shells were exhibited; and of them he stated, that there were three, viz., sanguinolaria tumida, atrypa glabra, and atrypa oblata, absolutely identical with fossils common in the quarries of Kildare.

Mr. M'Coy then drew attention to the fact, that, at the present day, if we except one or two migratory birds, there is not one of the animals of New Holland identical with those of Europe; and that even most of the living Australian genera are peculiar to that continent; and arguing from this, and the identity of the mountain limestone fossils of New Holland with our own, he drew the conclusion, that, either at the time of the deposition of the older fossiliferous rocks, there was a nearly uniform temperature over the whole globe, admitting of a wider geographical range to animated beings than at present; or, should such doctrine be considered untenable, that the fossiliferous rocks, taken individually, are of very different ages in different countries; but that where two formations, differing much in geographical position, contain the same fossils, the mean temperature of the localities in which they are situate must, at the periods of their deposition, be concluded to have been the same.

In further illustration of this view, Mr. M'Coy stated, that he had recently found a number of fossils, from the Himaleh

mountains, to consist of fractured ammonites, orthoceratites, &c., altogether the same with those which occur in the lias of Yorkshire, a result which, he added, was since confirmed by Mr. Sowerby.

Mr. M'Coy concluded his paper by a detailed description of a new Australian spirifer, which he called Spirifer Novæ Hollandiæ, and which he stated to be distinguished from all other species of the same genus, by having but *two* ribs on each side of the mesial fold.

His next communication was a continuation of a paper read by him the preceding season, on the new fossils occurring in the collection of this Society. In this he describes as new species, some cephalopoda from the lias, some shells from our Irish carboniferous limestone, and a trigonia from the green sand of Kent; on which, however, I need not dwell, as an account is given of them in the catalogue of the Society's fossils drawn up by Mr. M'Coy, and which, I have great satisfaction in stating, has just issued from the press.

On a subsequent evening, Mr. M'Coy exhibited a small piece of common carboniferous limestone from Clane, County Kildare, containing several entomostraca of exceeding minuteness, belonging to the recent genus cythere, and to the new genus entomoconchus, established by him in his paper published in the last number of our Journal. He stated, that he had distinguished in his manuscripts fourteen species of these interesting little animals, hitherto unnoticed by geologists, as occurring in marine formations.

I am sure I am but giving expression to the feelings of all present when I say, that we estimate very highly these communications of Mr. M'Coy's. He has devoted himself, and continues to do so, with great ardour and disinterestedness to the cultivation of an almost unexplored field, the organic remains of Ireland; and while earning for himself considerable distinction in this difficult department of science, he is adding daily to those facts, which, ever since their in-

fluence and value were first pointed out by Dr. William Smith, have been found to assist and illustrate in so high a degree the speculations and the researches of the geologist.

I have now, Gentlemen, disposed of the various papers and communications brought before us during the past year, with the exception of one from Mr. Griffith, which accompanied the beautiful geological map of our Island, hanging behind the chair, upon the occasion of its being presented by him to our Society.

This map is a copy of a new edition of his large map published by him in June last, and the paper just mentioned consisted principally of a schedule of corrections introduced into this second edition.

Of the number and extent of these corrections, some idea may be formed, when it is stated, that they are introduced into at least forty different parts of the map, and that the enumeration given of them is professedly incomplete. When we reflect upon this amount of change, effected in a single year, and by Mr. Griffith's personal labours, we feel astonished at, and grateful for his activity as a geologist; but at the same time, also, satisfied that his map must undergo many and great additional alterations before it can be considered to represent, with anything approaching to precision, the structure and stratification of our country. Upon the publication of the first edition of his map, Mr. Griffith would seem to have considered Irish geology as an almost exhausted subject. He admits, indeed, (Philosophical Magazine, March, 1840, p. 161,) "that much detail requires to be worked out within the great divisions, particularly in the carboniferous limestone series; and that many of the smaller greenstone protrusions have yet to be pointed out." But he is fully of opinion, "that the great lines, nearly represent the true boundaries of the several rock formations, according to the order of superposition indicated by the table of geological colours."

This is an opinion in which I never could concur. For Mr. Griffith's talents, and his labours in the field, we can entertain no feelings but those of great respect. To Mr. Weaver and to him we owe the greater part of what is known of the stratification of the south, and south-eastern part of Ireland, and to his lectures delivered at the Dublin Society, combined with those given by Dr. Stokes, in Trinity College, we may attribute the fact, that a sufficient number of persons taking an interest in geological pursuits, existed in this city, some nine or ten years ago, to constitute the nucleus of our Society. It is, however, no reproach to Mr. Griffith to allege that the surface of our country is too vast, the nature of its strata too varied, and their geological position and relations, often too difficult to determine, to admit of the problem of Irish geology being solved, even as far as respects "the nature and boundaries of the different formations," by the unaided efforts of any individual however ardent, and however accomplished. When Mr. Griffith reflects upon the long list of changes effected, as he tells us, by himself in the space of twelve months, it is impossible he can be of opinion that no further corrections of moment require to be made, and that the Irish geologist has henceforward only to direct his attention to "details connected with the carboniferous series, and to the pointing out new greenstone protrusions." It is impossible, I say, that such can still be his conviction, for he has himself given us, in his schedule, instances of departure from his first map, not only in matters of detail, but in points affecting those boundary lines and the relative position of the rocks themselves, which in his address from this chair on this day twelve month, he announced it to be his duty to defend "from all inroads."*

In illustration of these remarks I shall now mention some of the changes of colouring introduced by Mr. Griffith into the new edition of his map.

* See his Address, p. 27, concluding paragraph.

The shale district, for example, containing thin beds of coal, situate to the south of Drumquin, county Tyrone, and previously coloured as millstone grist, he now considers as a member of the calp series, and colours accordingly. We have here an instance of a change of view as to the geological relations of these strata; for if they be an interpolation in the calp formation, they must occupy a considerably lower position than if they belonged to the millstone grit.

In the county of Monaghan we have an instance perfectly similar to that just mentioned; for a district, to the west of Carrickmacross, previously coloured as belonging to the coal formation, is now represented as the yellow sandstone which is sometimes found associated with calp.

It would be tedious to enumerate the many instances in which Mr. Griffith conceives that he has mistaken old red sandstone for the yellow sandstone, which he represents as constituting the basis of the lower limestone, and as occasonally interstratified with it. They amount to eighteen or twenty; and involve changes of opinion as to the nature of the rock which constitutes the chief mass of extended ranges of mountains, as those of Slieve Bonn in Roscommon, Slieve Moray, in Galway, the Devil's Bit and the Keeper mountains of Tipperary, the Slieve Bloom chain of the King and Queen's County, the mountains to the north and south of the schistose range of Carnclon Hugh, in the County of Leitrim, the detached hills in the vicinity of Moate, County Westmeath, &c. &c.

Though the range of the yellow sandstone is thus limited by Mr. Griffith, the rock is, of course, still retained by him, and represented in many localities as constituting narrow bands separating the old red sandstone, on which it rests, from the lower limestone, which it supports. New stripes of it are even introduced in the vicinity of Nenagh, and to the south-west of Ardee in the county of Louth.

Of the chief of these alterations I make no doubt that

geologists will generally approve. The extent of the yellow sandstone, as depicted in the first map, always appeared to me to be too great; and I am of opinion that it will undergo further curtailment whenever the grounds of distinction between the yellow and old red sandstone, pointed out by Mr. G. himself, shall be rigorously acted on, and all arenaceous rocks below the carboniferous series shall be referred to the old conglomerate, unless they should contain the fossils, or intercalated strata of the carboniferous limestone.

In connexion with this subject, and as illustrative of the changes which the great innovator and instructor, Time, is sure to introduce into the most laboured performances, it may be stated, that Mr. Griffith places, for the first time in his last map, a hill immediately to the south of the town of Longford, consisting of old red sandstone, resting on transition slate. I may also mention here, though it is unconnected with the general argument, that in the schedule so often alluded to, corrections are mentioned which have not been made. Thus Mr. Griffith mentions, that a band of *upper* limestone is exhibited as bounding the millstone grit of the Queen's County, and counties of Kilkenny and Tipperary, but such is not shown upon the map, the lower limestone being that which is represented as in contact with the coal measures on every side.

I shall now briefly draw attention to an alteration of colouring, mentioned by Mr. Griffith in his list of corrections, but to which no allusion has as yet been made.

You are, I believe, Gentlemen, all aware, that it has been proposed by Mr. Murchison and Professor Sedgewick to subdivide all the sedimentary strata below the old red sandstone into two leading groups, the upper of which has been termed the *Silurian*, and the lower the *Cambrian* systems. Mr. Murchison, who has published an elaborate work upon, and obtained much celebrity by his able investigation of the silurian strata, distinguishes them from rocks both above and below

them in geological position, by the peculiarity of their organic remains: and, relying on the same grounds of distinction, has formed four subdivisions of the silurian group, viz., the Ludlow, Wenlock, Caradoc and Landeilo,' indicating, by this very singular nomenclature, which would seem characteristic of English geology, the situations where these formations are most completely developed. Now, in his first map, these rocks are not any where exhibited by Mr. Griffith, except at Pomeroy, in the county of Tyrone, to the east of which a limited silurian district is shewn, which has been very carefully investigated by our former President, Captain Portlock, and in which he has discovered a number of very interesting fossils, chiefly belonging to the family of trilobites.* (See Ordnance Memoir of Derry.) In his last edition, however, the silurian strata occupy a very considerable surface indeed. Thus the greater part of the barony of Corkaguinny, constituting the peninsula which stretches seaward between Brandon and Tralee bays on the north, and Dingle bay on the south, and which was previously coloured as clay-slate, is now coloured as silurian, with the exception of a narrow stripe extending from the western base of Cahirconree mountain to Foilaturrive on the bay of Dingle. But the most extensive silurian region lies to the south and a little to the

* Captain Portlock, proceeding on the principle, that the foundations should be carefully laid for geological deductions before these deductions are drawn, has continued to investigate the fossils of the northern counties, and is preparing a monograph on the subject, the publication of which will shew, that though the silurian district of Tyrone is limited in extent, it is particularly rich in the fossils characteristic of such formation. This monograph will contain descriptions of at least forty species of trilobites, exclusive of fossils belonging to other classes, and which will be found equally numerous. I should not omit to mention, that Captain Portlock has carefully compared the silurian trilobites with those of the mountain limestone, and that he has arrived at the very interesting result that the former are generically distinct from the latter. It is much to be hoped that this most interesting publication may not experience any unnecessary delay.

east of this, and may, in a general way, be described as comprehended between the sea and two lines, one of which extends due east through M'Gillicuddy's rocks and Millstreet to the Bochra mountains, and the other from these mountains to Dunmanway and the sea. All the rocks comprehended between these lines are represented as silurian, with the exception of a little old red sandstone, and carboniferous slate at Bantry Bay, and some old red sandstone with narrow stripes of yellow sandstone, and carboniferous limestone in the valley of Kenmare. The only other silurian rocks depicted by Mr. Griffith are some at Lambay, and the opposite shore at Portrane. They are associated with old red sandstone, and some porphyritic portrusions, and cover but a very trifling area.

That many of these rocks are properly classed with the silurian group of Murchison, there cannot be any doubt, for the question has been tried by the test of organic remains, which,[1] in such case, at least, may be considered as decisive. Fossils, for example, collected from the limestone on the shore below Portrane deer-park, have been declared to be upper silurian, by Mr. Murchison, and Mr. Lonsdale ;* and others collected at Ferriter's Cove, in the peninsula of Dingle, have been recognized by Mr. Sowerby to belong to the same formation.† But where, from the absence of organic remains, the criterion of fossils cannot be applied, and that the old red sandstone series rests conformably on the transition strata, and that both formations are largely developed, consisting of a vast mass of intermingled arenaceous and schistose rocks, it sometimes becomes difficult to say that all are not of the transition or of the incumbent class, or to draw the boundary line between the two series, and say, where the one terminates and the other begins. This difficulty is par-

* See Mr. Griffith's Address of February, 1840, p. 26.

† See paper by Mr. Griffith in Phil. Mag. for March, 1840, pp. 166-7.

ticularly felt in the vicinity of Killarney, and, accordingly, a controversy has arisen, and a difference of opinion, I believe, still prevails on the geology of this district, between Mr. Griffith, on the one hand, and Mr. Weaver, and our zealous and talented Secretary, Mr. Charles Hamilton, on the other. Into this controversy it is not necessary for me to enter, as no part of it came under the cognizance of the Society during my year of office. I may, however, in passing, observe, that the views of Mr. Griffith, which he supports with his usual ability, are based upon the supposition of a great fault, which crosses the gap of Dunloe, nearly at right angles, and extends from thence in a south-eastern direction, to the base of Turk mountain; a fault which must have produced an up-lift of the strata to the south, to the extent of at least 3000 feet, and the existence of which is, nevertheless, denied by Mr. Weaver as well as by Mr. Hamilton. I certainly incline to the opinion of Mr. Griffith, that the limestone of Killarney, like that of the valley of the Laune, is carboniferous, but there are other points which do not appear to me to be equally well established. Thus, without again alluding to the subject of the fault, and the phenomena it is intended to explain, topics, however, which, in my opinion, constitute very debateable ground indeed, I may observe, that the boundary line drawn by Mr. Griffith between the old red sandstone and silurian rocks, situate to the south of Dingle Bay, is one on which but little dependance can be placed, seeing that it has been suggested by a supposed analogy between these rocks and those which occur northward in the peninsula of Dingle, an analogy which fails in a most important particular, seeing that the Dingle old red sandstone occupies an unconformable position in reference to the rocks which it overlies; while that to the south of Dingle bay conforms exactly (according to Mr. Griffith) to the subjacent strata. But I must not proceed further with these remarks, which, however, it is scarcely necessary for me to say, are not intended

as a decision of disputed questions in our science, but merely to draw further attention to a district which deserves, and will, I make no doubt, reward a more minute examination than any of which it has yet been the object.

There is one fact in reference to the south-western extremity of our island coloured as silurian, which should be held in recollection, viz., that in no part of it but the western extremity of the peninsula of Dingle, have fossils been found characteristic of this formation. The rest has been coloured as silurian, it is to be presumed, from a supposed resemblance of its rocks with those of Dingle in mineral structure, and geological relation, a resemblance which, from the very different position occupied by the old red sandstone in the north and south of Dingle Bay, is far from being as complete as might be desired.

And here it is natural to inquire, why other silurian districts are not exhibited on the map. At Grangegeeth, for example, in the county of Meath, Mr. Griffith informs us, (see his Address, page 28,) that fossils have been found which were pronounced by Mr. Murchison to be lower silurian, or of the period of the Caradoc sandstone; and, nevertheless, neither here, nor in any other part of the extensive grauwacke district to the north of Slane and Kells, have we a single dash of yellowish-green to indicate the existence of a silurian rock. Mr. Griffith also tells us, in a note appended to his last map, that silurian fossils have been found in the schist, on the coast of Waterford, at Knockmahon. Such is undoubtedly the fact. They were first noticed by Mr. Weaver, in 1824; and subsequently, in 1833, by Mr. Holdsworth, in a paper published by him in vol. i., part 2, of our Journal. More recently they have been found in considerable number in the vicinity of Tramore, by Lieutenant James, R. E., attached to the Ordnance Survey service. Lastly, Mr. Griffith has had several of them collected for himself, in this latter locality, and brought them

at Glasgow, under the consideration of the geologists of the British Association.* But, notwithstanding the notoriety of this fact, none of the transition rocks of Waterford are represented to belong to the silurian epoch. Now, what is the reason of this? That assigned by Mr. Griffith, viz., "that until the entire of these districts be searched for fossils, it would be indiscreet to attempt the separation of the silurian from the grauwacke series;"†—he can scarcely be permitted to employ, when we consider the grounds upon which the silurian colouring was laid on in Cork and the greater part of Kerry. Let us suppose—a very unlikely thing indeed—that upon investigating the schistose rocks of Waterford and Meath, silurian fossils could be found only in the localities of Grangegeeth and Knockmahon. Would Mr. Griffith, in such case, if he were bringing out a new edition of his map, limit the silurian colouring to these particular localities; or would he, relying on identity of mineral structure, give it a greater extension? Should he pursue the former, and probably the more prudent plan, I can only say, that he would be acting upon a principle very different from that by which he was influenced in laying down the boundaries of the same formation in the greater part of Kerry and Cork.

On the whole, then, I would say, that the only districts in our country, which have been proved to be undoubtedly silurian, are the western end of the peninsula of Dingle, part of Lambay Island, with the opposite coast at Portrane, and the vicinity of Slane, County Meath, all of which have been investigated by Mr. Griffith; the district of Pomeroy, in Tyrone, examined by Captain Portlock; and the schist, about

* This historical sketch requires a little correction; for, upon referring to Mr. Griffith's paper on the Geological Structures of the South of Ireland, published in vol. ii. part 1, of our Journal, I find, page 84, that previous to June, 1839, he had submitted the Knockmahon fossils to Mr. Murchinson, and also to Mr. Sowerby for examination.

† See note attached to his last map.

Bonmahon and Tramore, in which silurian fossils were first found by Mr. Weaver, subsequently by Mr. Holdsworth, and more recently and in greater number by Lieutenant James, and Mr. Griffith. With respect to the extensive region south of Killarney, represented as silurian in the map, I can only say, that it may or may not be such, but that the evidence in favour of the affirmative view, as far as I am in possession of it, is decidedly incomplete.

I shall conclude these observations by a remark or two upon the extensive district, coloured by Mr. Griffith as carboniferous slate, and which occupies the greater part of the southern portion of the county of Cork.

Its geological position is said to be between the old red sandstone and the carboniferous limestone; but at its commencement it is described as being interstratified with yellow standstone, and, as in many places, containing intercalated beds of carboniferous limestone.

Now, the first point connected with this subject deserving of attention is, that this carboniferous slate is considered as a transition slate by Mr. Weaver, no mean authority on such a question. The second is, that a similar view was entertained by Mr. Griffith himself, even so far down as 1838; for in his small map, attached to the Report of the Railroad Commissioners, this slate is coloured as belonging to the transition, or grauwacke series. The third point which I conceive it important to notice is, the great extent of area which it covers in this district. In other localities, where this rock is noticed, there are but thin and insignificant seams of it; but, in the south of Cork, it stretches in a north and south direction about fifteen, and in an east and west direction about fifty miles. The thickness of this rock we unfortunately do not know; for Mr. Griffith nowhere mentions the angle at which the strata dip, and whether this be constant and always directed to the same point of azimuth. This, I say, is to be regretted; for if it could be shown that this schist dipped at

a high angle, we would have grounds at least for suspecting that it was geologically a different rock from that which, occurring in other localities in laminæ of trifling thickness, has received the same name. I do not feel myself in a predicament to hazard any opinion as to whether the so called carboniferous slate of Mr. Griffith is or is not a grauwacke schist; or, what amounts to the same thing, whether the calcareous beds it includes are carboniferous or transition. It is, in fact, a difficult question; and I agree with Mr. Weaver, that it is not decided by the admitted fact of the limestone beds associated with the slate containing fossils of the mountain limestone. But is there no third view of this matter entitled to consideration? I do not hesitate to say there is, viz., that the schist in question is the upper part of the old red sandstone, not the lower member of the carboniferous system. Such an opinion may, in the present state of our knowledge, be plausibly maintained; and it is certainly not negatived by the nature of the fossils which the schist contains, seeing that there are many organic remains common to the old red sandstone and the carboniferous formations. If, of the fossils found in this rock, one be pointed out, which can with certainty be said to be peculiar to the one formation or the other, the question is decided; but I do not know that anything like this has been attempted. In the meantime, therefore, and that we may make some progress towards the solution of a disputed point in geology, I would entreat of such members of this Society, as may visit the southern extremity of our island, to study with attention the fossils of Mr. Griffith's carboniferous slate, and its relations to the strata on which it rests, particularly with the view of determining whether they are conformable or not. The result of such an examination it is not for me to anticipate; but I certainly should not be surprised to find it proved, that the slate in question was one of those Devonian rocks, so called by Professor Sedgewick, which constitute the upper members of the

series of the old conglomerate, in localities where this series is largely developed. This opinion, I may add, has been already ably maintained by Mr. Charles William Hamilton, and even extended to the entire system of rocks, south of Killarney, coloured as silurian by Mr. Griffith.

In the observations which I have just made, I am sure I shall not be misunderstood to have insinuated censure, or pronounced a positive judgment on any controverted topic; such is not my province, and has certainly not been my intention. The object which I have principally had in view has been, while drawing attention to a work which has conferred such deserved distinction on Mr. Griffith, to remove the idea, should it be prevalent in any quarter, that in Irish geology little further remains to be accomplished. Mr. Griffith has done much, probably more than any other living geologist, towards developing the mineral structure of our country; but many inquiries of importance are altogether untouched by him, and many received views will, I make no doubt, prove erroneous or imperfect. Let us then apply ourselves with zeal and with hope to those studies and researches which, as Members of this Society, we are bound in every way in our power to forward and promote; and, while endeavouring to fill up the chasms which exist in the geology of Ireland, I trust we may continue to reckon upon Mr. Griffith's able and cordial cooperation; he has the talents, the opportunities, and I am sure he does not lack the will, to assist us.

There is one other point connected with this map upon which I think it necessary to observe.

In point of fact three maps have been published by Mr. Griffith. First, a map on a comparatively small scale, and which appeared in connexion with his Outline of the Geology of Ireland, attached to the Report of the Railroad Commissioners; and, subsequently, a first and second edition of his large map, with which we are all familiar. We have

already seen how great are the discrepancies between the two larger maps, but they may be said to be of trifling moment, indeed, compared to those which present themselves when the small map is compared with either of its successors. Thus without entering into minute details, and, confining our attention to formations of considerable extent, it will be sufficient to say, that the schist of the south of Cork, which is transition in the small, is carboniferous slate in the larger one; and that in the former not a vestige of old red sandstone is exhibited in any part of the South of Ireland, with the exception of a small tract to the east of Mill-street, and a couple of others of similar extent to the north and south of Castlemain harbour, its place being supplied by what Mr. Griffith, in his "Outline," denominates a *newer* transition series; which term, as far as it is intelligible to me, would seem to imply that our old conglomerate was a silurian rock.

In the latter map this has been very properly altered, and the old red sandstone is correctly exhibited as constituting the Knocktopher, Galtee, Commeragh, Monavullagh, and Knockmildown chains of mountains, and generally the greater part of the hilly region of Waterford and Cork. Whatever may be thought of Mr. Griffith's carboniferous slate, there can be but one opinion as to the propriety of recognizing the existence of the old red sandstone in most, if not all the localities in which it is now represented. But what may be complained of is, that Mr. Griffith should sometimes not only have left us in the dark respecting the chronology of these changes, but by erroneous dates have rendered it very difficult for others to arrive at the truth. The smaller map is dated April, 1838, and this, for aught I know, may be correct; but the first of the larger maps is dated March, 1839, which, I think, must be a mistake, as I am informed by a friend, that he could not procure the map at a considerably later period; and as the copy presented

to us, and which was, I presume, an early one, did not reach its destination until the middle of June. And here, in passing, I may observe, that in the interval Mr. Griffith had the benefit of Captain Portlock's valuable suggestions, who in his Address, from this Chair, of February, 1839, recommended the principal changes of colouring which distinguish the second map from its predecessor. But, however this may be, we certainly find, as respects the two larger maps, that though differing from each other in a number of most important particulars; and though prepared and published at different times, they have both the same date, viz., March, 1839. What the object of this can have been is more than I am able to divine. It is probably an inadvertence; but from whatever cause it may have originated, it is much to be regretted, as it has a direct tendency to involve in confusion the history of geological discovery in Ireland.*

I shall now conclude with a few remarks upon the actual position, and future prospects of our Society.

And here, Gentlemen, I have to regret being unable to address you in those terms of congratulation and triumph which it would be so agreeable to my feelings to be at liberty to employ. Our Society is in the tenth year of its existence, and during this period, I think I may say, that we have never lost sight of the great object which brought us together,— " the investigation of the mineral structure of the earth, and more especially of Ireland." A great number of original and important communications have been brought before us, re-relating principally to the geology of our own country, and of these a selection has been made, and given to the public through the medium of our Journal, of which five successive Numbers have appeared, each of which consists of from nine

* See Appendix for a letter from Mr. Griffith, having reference principally to the preceding observations upon the dating of his maps; subjoined will be found my reply.

to ten sheets. We have also, after great efforts, and the incurring of considerable expense, aided, however, by the ge nerosity of scientific strangers, and of some zealous Members of our own body, succeeded in acquiring a cabinet of minerals and fossils, possessing a rare value, and to which, now that it is arranged and catalogued, the student in geology may advantageously resort, to clear up doubtful points, and familiarize himself with the rocks, and the fossil zoology of our country. All this has been done by the spontaneous efforts of individuals, held together by no bond but the love of science, and stimulated only by the desire of being instrumental in the diffusion of a species of information which has the most important practical bearings on the interests of Ireland.

Having thus briefly stated our objects, and the progress we have made towards the realization of these objects, I have now to make the humiliating avowal, that the support we have received, instead of increasing, is on the decline, and that unless some successful effort be made to rescue us from our embarrassments, our career may, and at no distant period, be altogether arrested.

When you reflect upon the nature of the Report read this day by our Secretary, Mr. Hamilton, you will be sensible of our difficulties, and acquit me of being an alarmist. Our income has of late exeeeded our inevitable expenses by so small a sum, that the printing of our Journal has been suspended; and should our inability to publish continue for any length of time, I need not tell you how injurious will be its reaction in other ways, by discouraging geologists from sending us their researches, and thus diminishing the interest of our Monthly Meetings. But I will not dwell on so unpleasant a topic, nor permit myself to apprehend a failure of that patronage and support, to which we could certainly never advance so strong a claim, as at the present moment. But if we fail, Gentlemen, it will be in a great measure the result

of our own culpable apathy. A very slight exertion on the part of our own Members, would readily bring us such accession of strength, as would enable us to prosecute, with increased energy and success, the important objects for which this society was instituted. I may add, that it is to ourselves, and to the public at large, that we must alone look. Some, indeed, have indulged the hope that assistance might be vouchsafed us by the legislature, but I believe such expectations are now in a great measure abandoned, and I must say, that I never participated in them. Parliament is seldom lavish of the public purse, except for political objects, and in these, as a body, we take no part or interest whatsoever. In other parts of the empire, it is true, legislative aid has been freely given. Thus, a medical school has, within a very short time, been connected with the Belfast Institution, and several, if not all of the Professors, have salaries paid out of the consolidated fund, salaries to which I *know* some of them to be well entitled from their high literary and scientific attainments.

It is, however, on the other side of the channel, in rich and flourishing England, that the full tide of legislative generosity is poured out. In the Philosophical Magazine for October last, you will find in a report of the able and eloquent address of Dr. Buckland, to the Geological Society of London, the following passage:

"Among the most important of these events, we recognize with gratitude, and confident anticipation of great advantage, both to science and the arts, the establishment, by her Majesty's Government, of an Institution hitherto unknown in England, namely, a Museum of ŒCONOMIC GEOLOGY. This is to be freely accessible to the public at stated periods, in the Department of her Majesty's Woods and Forests, and Public Works, for the express objeet of exhibiting the practical application of geology to the useful purposes of life. In this Museum a large store of valuable ma-

terials has already been collected and arranged, chiefly by the exertions, and under the direction of Mr. De la Beche. In it will be exhibited examples of Metallic Ores, Ornamental Marbles, Building-stones and Limestones, Granites, Porphyries, Slates, Clays, Marls, Brick-earths, and Minerals of every kind produced in this country, that are of pecuniary value, and applicable to the arts of life. Information upon such subjects, thus readily and gratuitously accessible, will be of the utmost practial importance to the miner and the mechanic, the builder and the architect, the engineer, the whole mining interest, and the landed proprietors. The establishment will contain also specimens of the results of Metallurgic processes obtained from the furnace and the laboratory, with a collection of Models of the most improved machinery, chiefly employed in Mining. A well-stored Laboratory is attached to this department, conducted by the distinguished analytical chemist, Mr. Richard Phillips, whose duty it already is, at a fixed and moderate charge, to conduct the analysis of metallic ores, and other minerals and soils submitted to him by the owners of mines or proprietors of land, who may wish for authentic information upon such matters.

"The pupils in this laboratory are already actively employed in learning the arts of mineral analysis, and the various metallurgic processes.

"A second department in the Œconomic Museum will be assigned to the promotion of improvements in Agriculture, and will contain sections of strata, with specimens of soils, sub-soils, and of the rocks from the decomposition of which they have been produced.

"To this last-mentioned collection proprietors of land are solicited to contribute from their estates labelled examples of soils, with their respective sub-soils; and all persons who wish for an analysis of any sterile soil, for the purpose of giving it fertility, by the artificial addition of ingredients with

which nature had not supplied it, may here obtain, at a moderate cost, an exact knowledge of its composition, which may point out the corrective additions which it requires. This portion of the Museum will more especially exhibit the relations of geology to agriculture, in so far as a knowledge of the materials composing the sub-strata may afford extensive means of permanent improvement to the surface."

This passage, I can truly say, I have read with great pleasure, though not without emotions of a different kind. We all hail "with gratitude, and with confident anticipations of great advantage both to science and the arts," the establishment by Her Majesty's Government of such an Institution. But is it unreasonable to inquire, why nothing of the kind has been attempted for Ireland? England is a rich, Ireland a poor country (I do not now speak of soil.) Is this any reason why we should not have the benefit of a Museum of Œconomic Geology? In England, agriculture is conducted upon sound and scientific principles; in many parts of Ireland it is conducted upon no principle at all. Which of the two countries stands most in need of agricultural instruction? We have also mines in Ireland, and have begun to work them too, and with considerable profit; but we certainly cannot pretend to that dexterity and skill in this most important branch of industry for which the miners of Great Britain are proverbial. If then it be decided, and decided wisely, that the Cornish miner may be materially benefited and improved by resorting to the Museum, and to the Laboratory of the Institution for Œconomic Geology; it surely will not be denied, that those who in Ireland are engaged in the same pursuits, would derive from such sources a more than proportionate amount of assistance. Why then, I would ask, have we not in Ireland some Institution analogous to that recently established in London, and which, in the opinion of the best judges, promises to ameliorate the condition and augment the resources of the happiest and wealthiest nation in the world?

To this question I will not venture to supply any answer; nor shall I pursue further a topic into which I have been insensibly drawn, but the full and free discussion of which would not be suited to the present occasion.

I may observe, however, that should our Government feel so inclined, and I am not one of those who doubt their disposition to benefit Ireland, it would be very easy for them indeed to establish in Dublin a school of practical science, not inferior to any existing elsewhere, and calculated, for the reasons already glanced at, to confer the most signal benefits on this part of the empire. The geological branch of the Ordnance Survey in this country still proceeds *pari passu* with that of England, though in the very last session of parliament it was, upon grounds of paltry economy, on the point of being suppressed. Through means of this department of the service, which is known to be under the direction of an officer of whose ability, profound and accurate knowledge of, and devotion to geological science, I would probably speak at greater length were I not forbidden by his presence; through means, I say, of the geological department of the Survey a most extensive and valuable collection of rocks, minerals, and fossils is in the possession of the Government, and even already arranged, so that it is at this moment fully available for the purposes of instruction. Here then is a cabinet to begin with, precisely similar, as to the manner of its acquisition, to that arranged by Mr. De La Beche, and which has been made the nucleus of the Museum of Œconomic Geology, established in the department of Her Majesty's Woods and Forests in London.

Into details relating to the other necessary elements of such an Institution I will not now enter; but will content myself with expressing a confident belief, that we possess resources at home for completing it upon a scale suited to the wants of our country, and at an expense absolutely insignificant when compared with the many advantages, material and moral, which may rationally be expected to flow from it.

APPENDIX.

2, *Fitzwilliam-Place, Dublin,*
12th February, 1841.

MY DEAR SIR,

I heard some of the observations contained in your Address of Wednesday night, relative to my Geological Map, with pain; because, if I did not mistake you, you appeared to think I had acted disingenuously in regard to the date of my Map, and by that means had endeavoured to make it appear that several subsequent changes were contained in the original Map. Now I hope to shew that this is not really the case.

With the exception of the several changes made in the year 1840, and set forth in the notes laid before the Society, which were alluded to by you, no alterations have been made in the large Geological Map since the meeting of the British Association at Newcastle-upon-Tyne, in the Autumn of the year 1838, at which time the identical Map which hung *so long* in the rooms of the Geological Society of Dublin, was exhibited and explained by me to the Geological Section. That Map was withdrawn from the Society's rooms on my presenting the present corrected copy, together with the list of corrections that had been made. It is to be observed, that the original Geological Map was coloured from an unfinished proof impression taken six months previously to the publication of the Map.

In the month of March, 1839, on the completion of the engraving, I coloured two copies from the original Map, one of which was sent to Mr. Gardiner, in London, and in May, 1839, I presented a

copy of this Map, coloured by Mr. Gardiner, to the Geological Society of London, when a paper was read by me, relative to the geological structure of the south of Ireland, and which contained a statement of the several corrections I had thought it necessary to make, from the small Map appended to the Report of the Railway Commissioners.

In June, 1839, I read my paper relative to the colouring of the Geological Map of Ireland in our Society, and then presented the original copy of the large Geological Map already alluded to, having none of the Maps coloured from the finished engravings by me at the time. This Map is dated 1838, the time it was coloured; but the second Geological Map, presented to the Society with the corrections, owing to the inadvertence of the draftsman, had on it the original engraved date, of March, 1839, and I cannot suppose that such inadvertence can have led to any error in respect to the date of the changes, as the list of corrections which accompanied the Map was dated June, 1840.

I have not yet published my new edition of my large Map, the only copy out of my possession, upon which any alterations have been made from that coloured in 1838, being now in possession of the Society, consequently that copy, with its accompanying notes, cannot have led the public or the Society into any error, in regard to the date of the alterations.

The foregoing observations will shew, that as the changes from the original Map on the small scale were made at least six months antecedent to Captain Portlock's address, delivered to the Society in February, 1839, no advantage can have been taken by me of any observations of his made at that time.

In regard to the fossiliferous slate of the County of Waterford, I have to observe, that the true geological relations of these rocks was first determined from a series of specimens sent by me, early in 1839, to Mr. Murchison, and the conclusions drawn by him are detailed in my paper, published vol. ii. part 1, page 84, of our Journal.

In respect to the alterations in several places from the yellow sandstone to the old red, perhaps too much stress has been laid on them.

The exact line of division between two rocks which usually graduate into each other cannot be determined; consequently, as the same person may take different views, at different times, respecting some peculiarities, which may have induced him to form different limits for the same series, such alterations cannot be said to detract from the general accuracy of the Map, particularly when doubts have been expressed by several geologists as to the propriety of making any distinction between the old red and yellow sandstone.

As to the observations relative to the silurian series and the carboniferous slate, I can make no objection, as every geologist has a right to express his own opinion. I believe your conclusions to be erroneous, because I think I have grounds for all the changes I have made in Cork and Kerry; but as to the omission of the silurian series in Waterford and Meath, it has arisen from want of time to examine the districts so as to determine the probable extent of the silurian rocks in each. It should be recollected, that the silurian series is only an upper member of the Cambrian, and no geologist has as yet accurately defined the limits of each.

I send this hasty letter for your information on certain points, in the full expectation that you will do me justice when you are made aware of the facts; and I am sure you are incapable of doing any thing else.

I send you a copy of my reply to Mr. Weaver's observations published in the *Philosophical Magazine*, in which, page 164, you will perceive a similar statement to that contained in this letter, relative to the dates of the publications of my Geological Map, has already been published by me.

I am, dear Sir,
Very faithfully, your's,

RICHARD GRIFFITH.

To JAMES APJOHN, Esq., M. D.,
President of the Geological Society of Dublin,
&c. &c.

28, *Lower Baggot-street,*
February 12, 1841.

MY DEAR SIR,

Upon returning home this evening at 6 o'clock, I found your letter before me, and though I have not been able to give it all the attention it is entitled to, I think it better to write you a prompt reply.

And, in the first place, I beg to assure you, that in the observations which I felt it my duty to make in my Address, I had not the remotest intention of attributing to you anything disingenuous or unfair. I stated some facts in reference to the erroneous dating of your successive Maps, and contented myself with expressing regret that such errors had been comitted, and pointing to the obvious consequences likely to result from them. Now, it gives me much pleasure to find, that upon *matters of fact*, as far as they were accessible to me, you and I are agreed. You admit your last Map to have been wrongly dated, "owing to the inadvertence of the draftsman," (I said it was probably an inadvertence,) and you also admit that its predecessor was *published* subsequently to the delivery of Captain Portlock's Address in February, 1839. I submit then, that I was fully entitled to draw the inference that you had availed yourself of Captain Portlock's suggestions, the more especially as, with a single exception, the changes of colouring made by you were those precisely he recommended.

It is true, you now say, that this Map, published some time in 1839, was preceded by one in 1838, in which the colouring was put on an unfinished engraving, but was, nevertheless, precisely the same with that presented to the Geological Society of London, in May, 1839. When you make this statement deliberately, I, of course, at once adopt it; but I am bound in my own defence to say, that when preparing my Address I was perfectly unconscious of having ever heard of this Map, and the truth of this declaration will probably be the more readily admitted when it is known, that Captain Portlock, an individual so much interested in geological matters, has been equally ignorant of a Map coloured in 1838, in a manner precisely similar to that coloured and published in 1839. That Captain Portlock knew nothing of such Map you will at once perceive by perusing the note appended to his Address of 1839; and, indeed, those

passages in the body of his Address which relate to your Map, all of which have reference to the small Map published in connexion with the Report of the Rail Road Commissioners. And here I think I may be permitted to inquire why you did not draw Captain Portlock's attention to this prior Map, and set him and the public right upon the point, and not preserve a perfect silence respecting it, until I, in the discharge of my duty as President of the Geological Society, ventured upon what can be considered as little more than a repetition of statements previously acquiesced in.

With your reply to Mr. Weaver, of which you are good enough to send me a copy, I was previously acquainted, having, in fact, read it some months ago with considerable attention. I confess, however, that I was not aware, when penning my Address, that you had made mention, in this reply, of your having exhibited a large Geological Map at the meeting of the British Association in Newcastle, in 1838; but as this reply was published in November, 1840, I certainly cannot, at least as respects the public at large, consider its evidence as satisfactory as might be desired, particularly as it is not asserted, *totidem verbis*, that this large Map was coloured precisely like that subsequently *published*; and as the opposite view appears to be fully borne out by your silence in reference to Captain Portlock's Address—as already explained.

But assuming the existence of this Map of 1838, of which I, of course, now can entertain no doubt, having your authority for it, it may still be questioned whether you are in strictness entitled to complain of anything I have said. It is, I believe, a general, as it is certainly a wise rule, that in discussions touching priority in matters of science, claims must be grounded on priority of publication; and you must admit that, the propriety of this rule being conceded, I have been perfectly justified in the remarks I have made.

The other points on which you touch are, as you yourself seem to think, of comparatively little importance. You will find that I do not misrepresent you as relates to the fossils of Waterford; and generally, I may say, that I have at least endeavoured to be accurate as to facts. And here I might close this hasty reply to your letter, but that I feel it would be wrong of me not to advert to one other matter on which you seem to lay some stress.

You state, for example, that the erroneous dating of your last Map could not "have led to any error respecting the date of the changes, as the list of the corrections which accompanied the Map was dated June, 1840." Now, in reference to this, I beg to say, that the Map was, or at least I conceived it was, *published*, but the schedule of corrections and accompanying date were merely *communicated* to our Society with a presentation copy of the Map. You inform me, indeed, now, of what I was altogether ignorant before, that this last Map is not yet published, but how was I to have known this? Was I not, in fact, justified in entertaining the opposite belief by the following passage in your letter of June last. "I send a very short and hastily drawn up schedule of the principal corrections which I mean to revise and prepare for publication *immediately* on my return to Dublin. I mean also to send corrected copies of the Map to the Messrs. Hodges and Smith, of Dublin, and Mr. Gardiner, of London, with a request that they will in future adopt the outlines and colouring of the new edition." And in this belief I may say I was confirmed by having been informed that the purchasers of the previous Map were invited to send their copies to Hodges and Smith, for the purpose of having the last changes introduced into them. And I may observe in passing, that had all the copies of the first edition been so sent in, and altered, there would be no permanent record of the fact of two distinct Maps having been published at all, seeing that the two editions bear the same date.

I have now, in conclusion, to state that I shall, if you should approve of it, solicit the permission of the Council to have your letter and this reply of mine printed as an Appendix to my Address, or, that I shall accede to any other arrangement which will enable you to establish your positions respecting the Map of 1838, and enable me to justify myself from the imputation of having made a groundless statement when I mentioned in my Address that you had, in preparing the first edition of the larger Map, the benefit of the observations made by Captain Portlock, in February, 1839.

I am, my dear, Sir,

Very faithfully, your's,

JAMES APJOHN.

To RICHARD GRIFFITH, ESQ.

THE ANNUAL REPORT

OF

THE COUNCIL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN,

FOR THE YEAR ENDING FEB. 10TH, 1841.

ought we not find it and trap to present many points of parallelism, and a close resemblance as respects physical properties and mineral constitution. Now, that such a resemblance does exist there can be no doubt. The ultimate constituents of both are pretty nearly the same. They are both destitute of organic remains, and both send off veins or dykes, which forcibly invade contiguous strata, producing in the rocks with which they come in contact, changes of a nature such as one would expect to result from the injection of streams of molten matter at an elevated heat.

As mineral masses, however, and in many other remarkable particulars, they differ strikingly from each other. Felspar, indeed, is a substance common to, and equally abundant in the two classes of rocks; but it is not so with the other minerals, of which they are composed. Mica, for example, is almost peculiar to the granitic formation. Hornblende, which is an essential element of trap, is found but occasionally in granite; and quartz, though occurring in both, is more largely and invariably present as a constituent of that formation, respecting whose igneous origin doubts are by some entertained.

The mineral character of granite, also, is much more constant than that of trap, whole mountain masses exhibiting throughout their entire extent the same appearance and texture. Granite also does not form conglomerates; it does not alternate with tuffs, nor does it ever occur in a scoriaceous, or vesicular condition. Lastly, the traps are frequently spread over and interposed between the stratified and sedimentary rocks; but this is rarely, probably never the case, with true granite. The facts just enumerated, and which are to be found in every geological work, admit of being easily verified by an examination of the primitive districts of our own country. In all the localities to which I have already adverted, the granite and trap may be studied in contact, particularly on the western coast, where the former rock is

pierced by a prodigious number of basaltic walls and whinstone dykes; the attentive study of which cannot fail to afford valuable helps towards the complete elucidation of the question to which I have thus cursorily directed your attention. A careful examination, I repeat it, of the relations of the admitted igneous protrusions which occur in such number in the different primitive districts, could not but throw considerable light upon a subject not as yet finally settled, and furnish new and probably decisive arguments in support of the theory which considers granite and trap as rocks identical in their origin, and explains the differences which undoubtedly obtain between them in structure, mineral character, and chemical composition; by the presence or absence of air or moisture in contact with them at the period of their production, and the different degrees of pressure to which, immediately previous to their transition from the liquid to the solid form, they were exposed.

And here I may observe, that to him who would devote himself to the study of the undoubted igneous rocks, Ireland is a country of exceeding interest. In numerous localities, as has been already stated, they occur as veins or dykes, which, though now solidified, were once in the liquid state, and in such condition injected into cracks formed by volcanic agency in preexistent rocks. They are presented, however, also under other circumstances, and upon a much more extended scale in several parts of our island, but more especially in Antrim, Derry, Donegal, Armagh, Louth, and Galway, to which I might add the King's County, Kildare, and the county of Limerick. In some of these districts we have magnificent colonnades of basaltic pillars, and extended fields of tabular trap; in others, huge masses of greenstone, constituting mountains, which, like Slievegullion, Slievegallion, and Carlingford mountains, reach nearly the elevation of two thousand feet. In others, again, hills, more or less conical, of moderate height, several of

which, as in Limerick, occur in the vicinity of each other. The rock of which these latter are composed is often porphyritic; in structure it is generally compact, but sometimes vesicular, usually amorphous, occasionally columnar, and, in a few instances, exhibits the characters of a trappean tuff, or conglomerate. The surface rocks disrupted in these localities are very different; but the changes experienced by all are of nearly the same character, and such as we now know, from direct experiment, are capable of being produced by the conjoint agency of a varying pressure and an elevated degree of heat.

As a kindred branch of geological inquiry, and one which may be prosecuted in Ireland with great advantage, I may mention the views originally suggested by Hutton, revived and greatly expanded by Mr. Lyell, and now very generally adopted, to account for the crystalline character and non-fossiliferous condition of the primary stratified rocks. That gneiss, mica-slate, and the associated beds of quartzite and hornblende schist, were originally sedimentary deposits, can scarcely be doubted by any person at all acquainted with the phenomena of stratification, as exhibited by the newer formations. But, whence it will be asked, have they acquired their crystalline character, and what has become of the organic remains, which, as aqueous deposits, they might be reasonably expected to contain? Such are the difficult questions to which Mr. Lyell has undertaken to reply. That his theory of metamorphism is constructed with skill, and sustained by ingenuity and research, will, I believe, be readily admitted. Upon its adequacy to explain all the phenomena, I will pronounce no opinion; but I think I am safe in saying, that he who is most familiar with the alleged metamorphic rocks is in the best position to criticize the theory by which their origin and present state is attempted to be explained; and that as these strata are largely developed in the various primitive districts of our country already enumerated, the speculation and

the facts can be here well studied in conjunction, and as accurate a decision as to the merits of the former come to, as is possible in the present stage of geological information and discovery.

We now arrive in an ascending order at the grauwacke or transition group of Werner, which occurs in many parts of Ireland, resting, of course, on the metamorphic rocks. How many interesting objects of research here present themselves? I shall, however, notice but one. In the south-west of Ireland the boundary line separating this system from the old red sandstone series is, in my opinion, far from being satisfactorily defined; and I do not know of any more promising field for the labours of the practical geologist, than the mountain districts to the north and south of Dingle Bay. These regions have been already explored by able observers; but those who have read their clashing statements, and are acquainted with the real difficulties which are there encountered, will, I doubt not, agree with me, that a good deal as yet remains to be done, and that renewed investigation is not unnecessary.

But there is another point connected with these rocks deserving of some attention: I allude to their subdivision into subordinate groups. This, as is well known, has been done for the transition rocks of England by Murchison and Sedgwick; but scarcely anything of the kind has, as far as I am aware, been attempted by the Irish geologist for the analogous strata of his own country. Which, for example, of our transition strata, are Cambrian, which Silurian? And, as respects the latter, have we in Ireland counterparts of the four subordinate groups into which they are divided by Mr. Murchison? or, if such be not the case, which are present, and which absent from the Irish grauwacke system? Now, Gentlemen, it is scarcely necessary for me to observe to you that the solution of those questions is reserved exclusively for the palæontologist. He, therefore, who would engage in such

an investigation, should, in the first instance, be possessed of specimens of the organic remains found throughout the entire series of Irish transition strata. Upon this very interesting branch, however, of geological research, we have been singularly apathetic; for though we possess, through the liberality of Mr. Hamilton, specimens from Herefordshire, which illustrate most of the divisions of Mr. Murchison's silurian system, we have not any from the similar strata of our own country, with the exception of a few from Ferriter's Cove in the peninsula of Dingle.

In one silurian district, indeed, that to the east of the village of Pomeroy, in Tyrone, a limited one, no doubt, the inquiry has been pushed to its utmost limits; and from the memoir upon its mineral and fossil geology preparing by Captain Portlock, the most minute and important information may be expected. To the publication of this memoir we all look forward with great interest, not only for the information respecting this particular district it will contain, but in the belief that it will serve as a sure guide to the investigation of other silurian localities which have either been not noticed at all, or are as yet but imperfectly explored.

The old red sandstone, or rock, which comes next in the order of superposition, occurs in many parts of Ireland; and from the area which it occupies, and the thickness of its beds, is certainly one of the most important members of the Irish series.

Now, should it be asked, does the Irish old red sandstone any where admit of the subdivision which has been applied to it in England, and present not merely quartzose conglomerate and sandstone, but the cornstone and tilestone groups which belong to it in Herefordshire, Worcestershire, Shropshire, and South Wales,—I fear there are few of us who could give a satisfactory answer to such interrogatory. That it will be found to include, in certain localities, some such stratified masses, I think by no means improbable; and should such

anticipation prove to be correct, we shall also, no doubt, encounter the singular fishes and icthyodorulites which characterize the two lower members of the Scotch and British old conglomerate. Those who have read the very interesting monograph by Mr. Miller, on this particular formation, will feel how important is the subject on which he has treated, and how far it is from being exhausted.

In passing from the old conglomerate to the incumbent carboniferous rocks, we find that the transition is generally accomplished by the interposition of beds of what Mr. Griffith distinguishes as yellow-sandstone, and describes as "sometimes free from the intervention of any other rock, but as frequently interstratified with dark-grey shales, and with dark-grey limestone more or less impure." I need not, I believe, remind the Members of the Geological Society, that this is difficult and disputed ground in Irish geology; but I will content myself here with this remark, as I shall probably have an opportunity, before I conclude, of again adverting to this important subject.

There is no country in the world of the same extent with our own in which the carboniferous or mountain limestone is so abundant, and I believe I may add, that there is no member of the entire geological series of rocks more interesting to the geologist, in consequence of the number and the variety of its organic remains. Nevertheless, until within a very few years, the fossils of our limestone were altogether neglected, or collected merely by those who prized them for the elegance or singularity of their forms, but were unable to render them tributary to the purposes of science. This is no longer the case. They are now purchased with avidity, and studied with enthusiasm, by competent persons; and from the discoveries in this department already made by some active members of our own body, several of which have been given to the world through the pages of our Journal, the attention of British and foreign palæontologists has been,

in an especial manner, directed to our country. Let us then pursue with ardour a work so auspiciously begun, and with the assurance that we are engaged in labours fraught with consequences of the utmost importance to the advancement of geological science. It is, alone, by a profound study of its fossils that we can resolve the carboniferous strata into distinct and well-determined groups. An attempt at their subdivisions has, indeed, been already made, but it can only be considered as a provisional one, and as awaiting many corrections and emendations, which can only be derived from those studies, the priority in the prosecution of which, I would, if possible, secure for the Members of this Society.

In studying the carboniferous rocks of Ireland, its coal fields will not fail to fix attention, for there are a number of points connected with them which require a more searching investigation than any of which they have yet been the object. There are seven distinct localities in Ireland in which coal has been raised. One of these, the Connaught coal district, which surrounds Lough Allen—the source of the Shannon—was at an early period separated from the rest by Mr. Griffith, it being, as he alleges, "in many respects analogous to the millstone grit of the North of England, as described by Professors Phillips and Sedgwick."* More recently, this separation has been carried much farther by him, for, in a letter which I had from him on the 14th of last month, he states, "there is no true coal series in Ireland, as far as I know, except at Dungannon and Ballycastle."

Now, what are the circumstances which justify the line of demarcation here drawn?—Is it because the combustible found in the southern districts is anthractic, and in the northern bituminous? No; this is not among the reasons alleged, nor could it be put forward with any plausibility, seeing that the same field will often, as indeed is the case at

* Outline of the Geology of Ireland, p. 15.

Ballycastle, contain the two distinct varieties of coal. Neither is the distinction in question founded upon differences in the geological position or mineral character of the northern and southern coal measures; for, as respects position, all but those of Antrim are said to rest upon the splintery, or upper division of the carboniferous limestone; and though the sandstone and grit are certainly in an unusual state of development in the Connaught field, this is not at all the case in the coal districts south of Dublin, in which, on the contrary, the sandstone is deficient, and the shale the predominant rock. But Mr. Griffith has not left us in the dark as to the reasons which induced him to classify the Connaught district with the millstone grit; for in his Outline, p. 15, he states that the difference between it and the true coal formation consists in the former containing abundance of marine exuviæ, while in the latter we find casts of terrestrial plants, and of fluviatole and lacustrine remains. Now, this reason would undoubtedly be satisfactory if it could be shown that the fossils of the Connaught and southern districts were, exclusively of marine, and of the true coal measure, of terrestrial or lacustrine origin. But as the opposite is notoriously the case, and that remains of beings that flourished on the land, in lakes, and in the sea, occur in all, it cannot be considered of so convincing a nature as to remove all doubts, and preclude the necessity of further investigation. These observations I throw out for the purpose of exciting inquiry, and of probably eliciting from Mr. Griffith himself the further motives by which he has been actuated in considering almost all of our coal formations as reducible to the type of the millgrit of the north of England.

The new red sandstone, or formation next in order to the carboniferous rocks, is not wanting in Ireland, though here, as in England, one of its most remarkable members, the muschelkalk, is wanting. Its uppermost bed, the keuper of the Germans, is, in an economic point of view, the most

important portion of the series, for it is in it that the rock-salt and saline springs occur in Cheshire and other parts of England. Now, though arenaceous, gypseous, and saliferous marls, are certainly encountered in the valley of the Lagan, from their association with the magnesian limestone of Hollywood, they probably belong to the German zechstein, a formation in which salt has never been found in any considerable quantity. In the red sandstone of Dungannon, in which the palæoniscus has been discovered, there is still less reason to expect any extensive deposit of sal gemme, as it undoubtedly corresponds to the fundamental grit denominated rothliegendes by the miners of Thuringia. May it not, however, be found to the north of Kingscourt in the County of Cavan? In this district Mr. Griffith mentions, that there exists a bed of gypsum sixty feet in thickness, a deposit which, when occurring in a similar geological position in other localities, is very frequently accompanied by rocksalt.

While expressing an individual opinion on these points, I trust I am also suggesting objects of research to the Members of this Society; for limited as is the formation on which I have been observing, it supplies materials for numerous interesting and important geological inquiries.

The remaining stratified rocks of Ireland are the lias, which includes both shale and limestone, green-sand, and chalk. These strata are confined to the north-eastern corner of our island, and the uppermost of them, the chalk, is itself covered by the thick mass of tabular trap to which I have already alluded.

The lias and green-sand are exposed only within a very limited area, being in greater part covered by the incumbent chalk and trap. At Portrush, however, the former is the surface rock, and occurring in a highly indurated condition, has been mistaken by able observers for an igneous product, but is now universally admitted to be the shale of the lias

formation altered by contact with a bed of trap. It abounds in the fossils characteristic of the lias, and these, which is a remarkable fact, are in a state of very complete preservation. Our museum includes a tolerably good collection of the organic remains of the lias; and the present Lord Enniskillen, some few years ago, presented us with a very perfect suite of the fossils which characterize the green-sand of England. You will, however, be probably surprised to hear that neither of them includes a single Irish specimen. As respects the chalk we are in a still worse predicament, for our collection of its fossils, viewed as a systematic one, is ridiculously imperfect, and contains but a single shell found in the north of Ireland. These, Gentlemen, are facts calculated to injure us as a scientific body, and we should lose no time in getting rid of the reproach of professing geology in the abstract, and neglecting that of our own country. The many eminent men, at home and abroad, who are engaged in the same pursuits with ourselves, naturally look to us for the most complete illustrations of the fossil fauna and flora of Ireland; but of such, in certain important departments, we are at present altogether destitute, and in no single one does our museum approach to completeness. Shall this state of things be permitted to continue, or should we not individually and collectively labour to make our cabinet such as would not only furnish ample materials for instruction to the junior geological student, but attract the visits of adepts in the science, to extend the number of their facts, or to correct their conclusions.

I trust, Gentlemen, you will not suppose that in the observations I have just addressed to you, I profess to enumerate the various points in the geology of Ireland deserving of your attention. Upon the subject of its metallic deposits I have said nothing, though I do not doubt that an accurate survey of our primitive and transition districts would add largely to the number of the mineral veins with which we

are already acquainted. I have made no allusion to the peat bogs of Ireland, and the remarkable mounds of limestone debris called eschars, by which they are so generally skirted. Nor have I touched upon the beds of clay at the S. E. extremity of Lough Neagh, said, but without the evidence of fossils, to belong to the tertiary era. These, and numerous other objects of equal, if not superior interest, will not fail to present themselves to him who has a taste for geological pursuits, and time to bestow upon one of the most fascinating and practically useful of the physical sciences.

I shall now proceed to the discharge of the task with which I am more specially entrusted, and present you with a succinct account of the different communications which have been brought before us in the course of the past year. They have not been as numerous as might be wished, but are certainly by no means destitute of geological interest.

At our meeting in March, Dr. Kane brought under the notice of the Society, a letter from Professor Karsten on the subject of a peculiar stalagmitic production found by him in a mine at Freyberg, and which is deposited from the drainage water in the vicinity of leaks in the pump mechanism, by which the mine is kept dry. Upon analysis this substance was found by Professor Karsten to consist of

Silica	18·98
Sesquioxide Manganese	25·01
Sesquioxide Iron . .	22·90
Water	33·00
	99·89

So that its formula is

$$\left.\begin{matrix} 3\ Mn_2O_3 \\ 3\ Fi_2O_3 \end{matrix}\right\} 2\ SiO_3 + 13\ HO.$$

It is, therefore, a hydrated silicate, analogous to certain zeolites.

This mineral would appear from the experiments of M.

Karsten to have its origin as follows: the strata composing the walls of the mine contain iron pyrites, which gradually oxidizing form copperas, and this acting on silicious fluor spar, an abundant mineral in the rock, gives rise to sulphate of lime, fluoric acid, silex, and silicate of the peroxide of iron; lastly, the sesquioxide of manganese is derived from the native carbonate, which is also present.

On the same evening Mr. M'Coy made a verbal communication on the subject of some new and rare fossils, found in the carboniferous limestone of Clane, County Kildare. In this he adverted cursorily to several alleged novelties belonging principally to the genera fenestella, gorgonia, gilbertsocrinus, pecten, modiola, orthocera, and goniatites. Amongst the rare fossils exhibited by him, I may particularize a perfect specimen of that singular shell, the orthocera paradoxicum, in which the incurved form of the apex was well shown. Mr. M'Coy gave it as his opinion, that this shell should form the type of a new genus, which would be analogous among the orthoceratidæ to the flat concave-backed nautilus, occasionally found in the mountain limestone. A considerable number of the conchiferæ of the carboniferous series were next exhibited. These, though often described as belonging to genera now living in our seas, were shown by the aid of very perfect specimens to present important generic differences, and to form, for the most part, types peculiar to the formation in which they are found. Among the genera thus noticed were retepora and flustra among the zoophyta; venus, corbula, sanguinolaria, lucina, solen, cardium, among the conciferæ; terebratula among the brachiopoda, and pileopsis, natica, melania, turritella, and buccinum among the gasteropoda. Lastly, he exhibited the cardium Hibernicum of Goldfuss and Sowerby, and, the specimen being perfect in all its parts, he undertook to show, that it in reality is not a cardium, and to corroborate the ac-

curacy of Professor Phillips, who has separated it as a distinct genus, under the name of pleurorhynchus.

At our subsequent meeting in April, Captain Portlock read to the Society a notice of M. Agassiz's celebrated work, "Etudes sur les Glaciers," and explained the theory of its author, his principal object being to induce the Members of our Society to search for evidences of its truth in Ireland. To many, perhaps to most of those who have visited the Alps, glaciers have merely appeared as huge masses of ice filling its higher valleys, beautiful and grand indeed, yet not inciting to much inquiry as to their causes or their effects. By the scientific observer, however, they were early considered subject to destroying and renovating agencies; and it was even perceived that these mighty masses were in motion, proceding from the higher regions where they were formed, to the lower where they are to melt away.

Several modes were advanced of explaining this movement of the ice. It was supposed by Playfair that the weight of the mass was sufficient to impel it down the inclined plain of the valley. By Gruner and Saussure, hydrostatic pressure was combined with gravitation, and this principle only asserted by them was much more fully advocated and explained by our fellow-member, Mr. Mallet. Mr. Charpentier, however, at the meeting of the Swiss naturalists at Basle, in 1838, brought forward what was then considered as a totally new theory of glaciers. The snow which falls in the Alps at places elevated 7 or 8000 feet, in other words, at points situate above the curve of perpetual congellation, undergoes no change of state. At lower levels, however, it is partially melted or fused together by the warm air into round granular masses, and, in virtue of a similar cause, these are in process of time converted into true glaciers. Now, these glaciers are traversed in a vertical direction by numberless capillary cracks, which absorb the water produced by the thawing of the snow above; and, when this encased water sub-

sequently congeals, there is produced a lateral expansion, which, it is easy to see, must tend to determine a downward motion of the entire mass of ice.

This method of accounting for the movement of the glacier is adopted by M. Agassiz, who, however, points out, that Charpentier had been anticipated in it by Scheuzer, in his Itinera Alpina, published in the year 1723.

It is unnecessary to dwell further on this still controverted explanation. That the glaciers do move is now doubted by none; and that they had even extended in past times somewhat further than their present limits, had been also suggested by Brard and Playfair. But Venetz, in 1831, was the first to demonstrate the former extension of the glaciers by well established facts; and Charpentier, who at first doubted the theory of Venetz, became, on examination, its most zealous adherent, and went so far as to assert, that they had extended to the Jura, and been the transporting agents of the Alpine boulders found upon its flanks.

To explain and develope this theory, so as to embrace by it the whole surface of the globe, is the object of M. Agassiz' work. For this purpose, it was necessary to select some definite appearances, some distinct facts, which could be ascribed to and connected with the agency of glaciers—such as the polishing and grooving of the surfaces of rocks in directions corresponding to those of the movement of glaciers, and the peculiar arrangement of those lines or banks of gravel and boulders, which constitute what are called *moraines*. Having explained the manner in which these effects are produced by existing glaciers, and more especially defined the causes which lead to the formation of the several varieties of moraine—*lateral* when extended in two lines near to and parallel to the sides of the containing valley—*medial* when formed in the centre of the valley, and *terminal* when forming a curved bank concave outwards, of earth or of stones in front of the glacier,—M. Agassiz proceeds to show, that such

appearances and such moraines can be traced in the Alps much beyond the present limits of the glaciers. Thus (quoting from Venetz) he observes, that "the villages of Reid, Bodman, and Hatten, in the Haut Vallais, are built on an ancient moraine deposited formerly by the glacier of Viesch now distant from them more than 1200 feet." And he adds several other equally striking examples, such as the great moraine of the valley of Kandersteg, now more than a league distant from the glacier of Oeschmnen; and proceeding from these cases of ancient moraines, which were once connected with glaciers still existing, he goes on to trace similar appearances in regions where no glaciers are now found, and to deduce from them the fact, that in such localities glaciers did once exist.

To this extent M. Agassiz may be considered to have only elaborated and confirmed the reasoning of Charpentier. He proceeds, however, much further, and advances the theory that such appearances may be traced in every portion of the northern hemisphere, and at comparatively low levels; leading to the conclusion, that prior to the present epoch of the earth's history there was a period of congelation, during which the whole surface of the globe was wrapped up in frost, the period probably at which the elephants of Siberia were destroyed, and encased in the newly-formed ice of these regions. This remarkable event M. Agassiz does not consider an anomaly in the course of nature, but rather as one of a series of similar revolutions, corresponding to the several geological epochs, the temperature rising, after each period of universal frost, though not quite as high as its previous level; so that the mean temperature of the globe continues to decline progressively in accordance with received geological views, though the regularity of this diminution is interrupted by a succession of great and abrupt depressions.

Whatever may be thought of this latter theory, the important generalizations connected with it have excited intense

interest. Mr. Renoir soon announced the discovery of similar phenomena of polished rocks and moraines in the Vosges; and M. Agassiz, Dr. Buckland, and Mr. Lyell, profess to have made similar discoveries in Great Britain and Ireland; to which may be added the results of M. Durochen's researches in the Pyrenees, and to a certain extent those of Mr. Bowman's, in Wales.

It is not surprising, that a theory so novel and so startling should share the fate of so many other theories, and be applied in explanation of facts beyond its legitimate scope. Hence it is, that every mound of gravel, whether situated in a fitting position or not, has by some been designated a moraine. But, if difficulties arise out of this too general application of a term, it must not be forgotten that M. Agassiz expressly says (page 317), "Moraines, properly so called, began to be formed only when the ice had retired into the valleys."

The well attested existence of moraines, and their concomitant phenomena, and hence of glaciers in valleys so far below the levels where they are now found, and in countries where the existing temperature would forbid the very thought of such phenomena, furnish certainly a very plausible argument in support of the idea, that ice had once spread over even the low lands of the temperate as it does now over those of the frigid zone. But, if such a state of things be admitted, it is easy to see that the melting of the ice must have given rise to a variety of phenomena—torrents, temporary lakes, floating fields and bergs of ice, leading to various modifications both in the wear of the earth's surface, and in the deposit of its detritus. To M. Agassiz, therefore, is due the merit of having opened to the geologist a new and fruitful field of speculation; and, whilst the grandeur of the conception itself is readily admired, equally so should be the zeal, energy, and perseverance which have induced him to spend days and nights in these drear and chilly regions, in

order that he might establish its truth on facts observed in the very focus of those sublime operations of nature.

In June I had the pleasure of reading a very interesting letter from Mr. Edward Barnes, upon the subject of the iron pyrites, at present raised in such quantity in the copper mine district of the Vale of Ovoca, county of Wicklow; and which, though long considered valueless, has at length become an article of considerable commercial importance, in consequence of its recent application as a substitute for sulphur, in the manufacture of oil of vitriol.

The mines which produce the pyrites are those of Ballygahan, Tigrony, Cronebane, and Conneree, which, though each of them is upon a different property, all contain the same sulphur *course*, as it is called by the miners, which traverses them in a north-eastern and south-western direction. This mineral occurs immediately at the surface, and is raised in large quantities down to the depth of fifty feet, the lode varying in width from four to thirty-six feet, and in hardness according as the pyrites is intermixed with poor ribs of copper ore, or with the argillaceous schist or killas, in which it is chiefly found. The amount of this deposit in the Vale of Ovoca would appear immense, since Mr. Barnes informs us, that the extent of pyrites ground now opened, and of ore actually in view, is adequate to the supply of the probable wants of these kingdoms for many years, without taking into account the additional quantity of it, which cannot fail to be discovered in the adjoining lands.

The most interesting facts in Mr. Barnes' letter are probably those which tend to show, that the sulphur and copper ores of this district are not distinct, but graduate into each other. Thus the copper ore of Ballymurtagh contains at least 30 per cent. of sulphur ore, and the greater part of the pyrites workings in the same mine contain about 2½ per cent. of copper. In corroboration of this latter statement, I may mention that several varieties of the Ovoca pyrites were some

time since analyzed in my laboratory, when all were found to contain copper, which, in the case of one specimen, whose analysis I subjoin, amounted to over 2 per cent.

Sulphur	41·73	= 78·00
Iron	36·27	
Sulphur	0·54	= 2·76
Copper	2·22	
Stony matter	19·24	
	100.	

The calx left by this variety of pyrites, after its sulphur has been burned off by the manufacturer of sulphuric acid, would be worth working for the copper; and I understand that an economical process for extracting the metal *viâ humidâ* from such residue has recently been devised. In connexion with this subject I may mention, on the authority of Mr. Barnes, that the water issuing from the pyrites workings is strongly impregnated with copper, and that upon being passed over plates of iron, it yields a precipitate containing from 10 to 30 per cent. of this metal.

When the demand for sulphur ore was at its height, the amount of it exported annually from Wicklow reached the enormous quantity of 100,000 tons. In consequence, however, of the recent adjustment of the question of the Sicilian sulphur, the demand for the Irish pyrites will probably experience a great diminution.

At our Meeting in January, Dr. Scouler read a very interesting paper on certain fossil crustacea, discovered by him in the carboniferous strata of the west of Scotland.

Dr. Scouler began by observing, that the crustacea hitherto found in the carboniferous and older formations, belonged chiefly, if not entirely, to the extinct tribe of trilobites, or to the class of entomastraca, while very few, if any, of the podophthalmous crustacea had been found in the older strata. He then drew attention to the fact, that of the crustacea de-

scribed by him two genera belonged to the division of podophthalmia, and one to the group of decapodes. The first genus, characterized by its very long beak approached to the modern genus palæmon, from which it differed in possessing didactyle claws to the first pair of feet. It, however, obviously belongs to the family of macrourous decapodes. The second genus belonged to the family of stomapodes, and was nearly allied to the squilla montis of our present seas.

In the same situation with the preceding fossil, Dr. Scouler detected a still more curious genus of entomastraca, which appears to be intermediate between the modern genera cypris and cyclops. Like the former genus, the fossil one is a bivalve crustacean, while, like the latter, it has a long articulated abdomen, which projects beyond the valves, and cannot be included within them. To this genus the name of dithyrocaris has been given.

The last fossil crustacean described, for the first time, by Dr. Scouler, was of a truly remarkable kind; and he admitted, that in consequence of its singularity, and the imperfection of the specimen in his possession, he was in much doubt as to its real nature, until this was pointed out by Professor Buckland, who, upon the fossil being shown him at the meeting of the British Association in Glasgow, threw out a suggestion, which, upon a reexamination of the animal, in which M. Agassiz assisted, proved to be perfectly correct. The anterior parts are alone preserved, that is the cephalic and thoracic portions; but from the gigantic size of these there can be no doubt that the animal was at least two and a half feet in length. The eyes were proportionally large, and of an elliptical outline, measuring one inch ten lines by one inch six lines. But its greatest peculiarity was its thoracic portion, which was covered with imbricated scales, a circumstance which has caused it to have been often mistaken for a fossil fish. To this genus the very appropriate name of Lepidocaris Bucklandi has been appropriated.

It is not, I believe, necessary for me to say one word upon

the great interest and value of this very original communication. A paper announcing so many and such discoveries can speak for itself; and I will only add, that we all feel indebted to its author for having brought his paper, which was prepared for publication elsewhere, in the first instance, before the Geological Society.

Upon the same evening two very important papers were communicated by Mr. Griffith, the one being entitled, a "Notice relative to the correspondence of the fossils of the carboniferous slate of the south of Ireland with those of the lower carboniferous limestone," and the other a "Memoir, descriptive of the alterations and additions that have been made in the Geological Map of Ireland during the years 1840 and 1841."

In his notice on the carboniferous slate, with which I shall commence, Mr. Griffith states, that in consequence of doubts having been thrown upon the propriety of his attaching the series of alternating arenaceous, schistose, and calcareous beds, which he has grouped together under this name, to the carboniferous limestone placed above them, rather than to the old red sandstone on which they rest; he has taken much pains during the past year to collect the fossils of the carboniferous slate, and has caused these to be compared by Mr. Frederick M'Coy, with the fossils of the admitted carboniferous limestone, and with those discovered in the north of Devon, and described by Professor Sedgwick and Mr. Murchison, and also by Professor Phillips, in his work on the Palæozoic Fossils of Devonshire. The results of this examination, as far as it has been as yet carried, he states to be as follows: "That out of 127 fossil species found in our carboniferous limestone, 53 are common to the carboniferous slate of the South of Ireland; and of 108 varieties of fossils which have been found in the carboniferous slate, about one-half are common to the beds of the lower carboniferous limestone. Of those common to the two de-

posits, 11 are zoophytes, 7 crinoidea, 3 conchifera, 25 brachiopoda, 1 gasteropoda, 5 cepholopoda, and one trilobita." "Comparing" (Mr. Griffith proceeds) "on the same principle the fossils of the carboniferous slate with those of North Devon, we find an almost perfect identity. Thus out of the 108 species of carboniferous slate fossils, 83 are common to the Devonian series, which is a very *remarkable as well as unexpected coincidence.** In regard to the zoological distribution, it is nearly the same as before, 15 zoophyta being common to the two series, 9 crinoidea, 4 conchifera, 45 brachiopoda, 1 gasteropoda, 5 cephalopoda, and 4 trilobita."

Such then are the facts established by the investigation originated by Mr. Griffith. What are the conclusions he deduces from them?—why, they are simply these: 1st. That the carboniferous slate is a member of the carboniferous limestone series. 2nd. That "from the correspondence of the fossil remains discovered in the carboniferous slate with those of the calcareous and schistose strata of North Devon, the Devonian series belongs to the same geological period, and should also be classed with the carboniferous limestone."

Now, of the correctness of these deductions, I will at once admit, that I am far from being satisfied; and I might go further and say, that I do not think the facts and the inferences in strict accordance with one another. That the Devonian rocks in question should not be confounded with the carboniferous series, but stand apart as a separate and older system, seems to me fully proved by the nature of their organic remains. Professor Sedgwick also, the value of whose judgment Mr. Griffith will be the first to acknowledge, seeing that in the memoir to which I shall presently have to draw your attention, he very frequently leans upon it, is still of this opinion, as is evident from the following passage in a paper read by him in November last, before the Geological Society of London. "Every for-

* These words are not in Italics in the manuscript.

mation" (alluding to the Devonian rocks) "with fossils intermediate between the carboniferous and silurian systems, must have an intermediate position—must therefore be upon the parallel of some part of the old red sandstone which fills that *whole intermediate position.*"—*Vide* Athæneum, December 5, 1841.

Assuming, then, this as an established point, it appears to me that what legitimately follows from Mr. Griffith's valuable researches is, that his carboniferous slate belongs rather to the Devonian than the carboniferous system, for 83 per cent. of its fossils are common to the former, while only 50 per cent. are found in the latter.

And here, I trust, I may be pardoned for calling to your recollection a passage in the Address which I had the honour of reading here this day twelvemonth. Speaking of the carboniferous slate, and of the views entertained respecting its geological position by Mr. Weaver and Mr. Griffith, I observe, "but is there no third view of this matter entitled to consideration? I do not hesitate to say there is, viz., that the schist in question is the upper part of the old red sandstone, not the lower part of the carboniferous system. Such an opinion, &c. &c." Now the data upon which I hazarded this opinion were, I admit, not very definite or sufficient. It gives me, however, pleasure to find that what was then little better than conjecture, has been, if not established, at least rendered probable by the very valuable investigations instituted by Mr. Griffith. That such is their tendency will, I think, be generally admitted, for there are, I believe, few geologists who will concur in the proposal to transfer the rocks of North Devon from the old red sandstone to the carboniferous system.

Mr. Griffith's second memoir relates, as has been already mentioned, to his Map of Ireland, a new edition of which he is preparing for publication, and an early copy of which edition he has, with his accustomed liberality, presented to our Society.

"During the last two years" he observes, "my chief object of investigation has been, to complete the subdivision of the carboniferous limestone series into three parts, the *lower*, the *middle* or *calp* series, and the upper, and, I am happy to say, I have made great progress in the work; and though the detail is not perfect in all its parts, still a sufficiently near approximation has been arrived at to enable me to lay down a general outline on the map."

From the remarks which I have already made on the subject of the subdivision of our mountain limestone into subordinate beds, you are aware of the difficulty of the inquiry in which Mr. Griffith has been so long engaged, and which there appears a prospect of his bringing to so successful an issue. I am sorry, however, to be obliged to say that he has not as yet put us in possession of the data necessary for enabling us to judge correctly of the progress which he has made. The classification in question, when originally proposed by him, was made to rest solely upon the differences, as respects mineral constitution, between the different parts of the carboniferous series. Now, the mineral characters of the calp are certainly so distinct as to preclude the possibility of its being confounded with any other portion of the formation, so that where the carboniferous series is complete, we are readily enabled to distinguish the calcareous beds below, and those above the calp. But where this latter member is wanting, and this is most frequently the case, it will, in my opinion, be impossible always to distinguish between the upper and the lower limestone viewed merely as mineral masses. This difficulty can only, as indeed I have already stated, be removed by a minute examination of the fossil zoology of the entire formation. Of this truth Mr. Griffith seems profoundly convinced. He has embarked with ardour in the study of the Irish carboniferous fossils; and having, as he himself informs us, secured the assistance of our associate, Mr. M'Coy, he hopes "to be able to determine, at no distant

period, the characteristic fossils of the lower, the middle, and the upper limestone, as well as those which are peculiar to each member of the series." It is very gratifying to find that so important an inquiry has fallen into such competent hands, and I trust that the period is not far distant when its results shall be communicated to us, and those expectations realized which the passage just quoted is calculated to raise.

Mr. Griffith, in his memoir, does not state that he has made any changes in the boundaries of his subdivisions of the limestone. I find, however, upon a comparison of his new map with that which preceded it, that these have undergone considerable alteration. Thus, the coal fields of Slieve Ardagh, Kilkenny, and Monaghan, which hitherto have been represented as resting on the lower, are now encompassed by belts of the upper or splintery limestone.* This latter rock, also, which in the preceding map is represented as supporting the millstone grit system of Lough Allen, has undergone, in this district, a great extension, being prolonged into the valley to the south-west of Brahlieve mountain as far as Tobercorry, and thus appearing, for the first time, as the surface-stone throughout a space, whose length is twenty-three, and average breadth eight statute miles. In connexion with this district, I may mention another of considerable extent, to the

* As bearing on this passage, it will be important to recall the following facts. Mr. Griffith, in his *Outline*, page 15, states that, "with the exception of the coal field in the county of Antrim, the whole of the coal districts of Ireland rest upon the upper or splintery limestone." The first edition, however, of his large map, subsequently published, is not so coloured. In the memoir accompanying the copy of the second edition of his large map, presented to the Geological Society of Dublin, he states as one of the alterations, that the limestone supporting the southern coal measures is represented to rest, not, as previously, upon the lower, but upon the upper limestone. Such change of colouring, however, was not made. In the present map, the limestone in question is coloured as upper, but without any allusion in his memoir to this alteration.

east of Castlebar, in which the upper limestone is now exhibited enclosing a central mountainous space, which is coloured as millstone grit. But the largest tract of upper limestone introduced into the new map lies to the east of Lough Corrib and the Bay of Galway, its area being, at a rough calculation, at least 500 square miles.

Of any changes which may have been made in the limiting lines of the middle member of the carboniferous series I cannot speak with any confidence, for I am unable to distinguish the shade of colouring by which this portion of our limestone is depicted in the old map. My impression, however, is, and if I am wrong I can be easily corrected, that large additions have been made to the calp, and that we now find it, for the first time, exhibited along the eastern side of the tract of newer limestone last described, turning, when it reaches the parallel of Athenry, to the south-east, and at the same time expanding so as to cover a large portion of the county of Galway. It is fit these alterations should be placed upon record. When the problem, in the investigation of which Mr. Griffith is so usefully engaged, shall be solved, they will stand as memorials of the difficulties he had to contend with, and of the perseverance and the skill with which he overcame them.

The rocks next adverted to by Mr. Griffith are his carboniferous slate and yellow sandstone. To the theoretical questions connected with the geological position and relation of these strata, I shall not return further than to guard myself against being supposed to conclude positively that the carboniferous slate belongs to the Devonian system. In the observations I have already made upon this point, my object has been to show, that the evidence from fossils adduced by Mr. Griffith, as far as it goes, tends to such a conclusion, and that I look upon this view as by no means improbable. I am, indeed, very sensible of the caution with which we should receive the reasoning in question, and that until we

are acquainted with all the fossils of the carboniferous limestone, the carboniferous slate, and the Devonian rocks, it will be very difficult to say, with certainty, to which of the two extreme systems the interposed shale belongs. Assuming, however, the view which we have ventured provisionally to take of the carboniferous slate to be correct, it follows irresistibly, that the yellow sandstone, which occupies a lower geological position, is also with propriety referred, not to the carboniferous limestone, but to the upper beds of the old conglomerate.

In regard to the boundaries of the carboniferous slate, the new map presents no material alterations.

In the positions of the yellow and old red sandstone, for, as will be recollected, these two belong, according to Mr. Griffith, to different formations, some important changes are exhibited by the new map when compared with its predecessor, which are specified in the memoir under consideration. The former rock is now exhibited over an immense tract in the north of Mayo, previously coloured as *lower* limestone, situate south of the parallel of Killala, and traversed by the high road leading from Crossmolina to Bangor. Of the propriety of this change I am in a predicament to speak from personal observation. I passed through the district in question a couple of times in the course of the past autumn, with Mr. Griffith's small map in my pocket, which in this part is similarly coloured to the large one which succeeded it; and after the most diligent examination, which under rather unfavourable circumstances I could make, I came to the conclusion, that in this locality at least, the map required alteration, and admitted of amendment. The eastern boundary line of this sandstone must be, in a great measure, conjectural, for it is generally covered with a deep deposit of peat, and its junction with the limestone of Crossmolina is, I believe, no where exposed.

The yellow sandstone Mr. Griffith describes himself as

having retrenched in another quarter, viz., the mountain ridge, which extends south-west from Lough Gara to near Swineford, replacing it by carboniferous limestone at the western end,—by old red sandstone, and by what he denominates metamorphic porphyritic sandstone. The distinguishing between yellow and old red sandstone has cost Mr. Griffith an infinity of trouble, and it would certainly be a curious result of his own researches upon the subject of organic remains, should they eventuate in proving that these two rocks are not geologically distinct, but form different portions of one great formation.

In Connemara and Erris, Mr. Griffith states, that the map has been greatly improved by numerous corrections of the boundary lines of the mica slate and quartz rock, and he also notices similar alterations along the flanks of the Ox mountains of the county of Sligo. A comparison of the map certainly shows that considerable changes have been made, and that these are improvements there can, of course, be little doubt. In the two former regions, however, and I particularly allude to Erris, the mica-schist and quartz are mixed up in so complicated a manner, that a perfectly accurate plan of the rocks, in all their details, can, in my opinion, never be given, until, with the Ordnance Map in his hand, every rood of ground is traversed by a competent observer.

On looking to the northern portion of the map, I miss the deep red colour hitherto appropriated to the extensive greenstone district of Slieve Gallion, which is now represented, and I believe correctly as respects a considerable portion of it, as consisting of a metamorphic hornblende schist; and casting the eye farther northward, I find a stripe of lias interposed on the western edge of the great tabular trap field between the chalk and new red sandstone, and extending in a waving line from the sea to Dungiven. These modifications of his map are, particularly the latter, far from being

uninteresting or unimportant, and yet they are not noticed in the memoir under consideration.

The further changes noticed by Mr. Griffith are but few in number. He has made no alteration in the boundaries of the old slate series, but now, very properly, colours as silurian, those districts of Meath and Waterford in which silurian fossils have been found. In the latter, he informs us, that igneous protrusions are so abundant as to constitute nearly one-half of the volume of the rock, but that these, in consequence of the inaccuracy of the county map, he was unable to insert. The igneous rocks, however, described by Major Austen, as occurring on the northern coast of Waterford Bay, westward from Hook Point, he has been enabled to lay down in their proper positions, having procured for such purpose, an early copy of the Ordnance Map of the southern portion of the county of Wexford.

Such, Gentlemen, is an outline of Mr. Griffith's memoir as far as relates to the amendments introduced into the new edition of his map. There are, however, other topics embraced by it. Thus he asserts, that a recent examination of the district has convinced him of the incorrectness of the suggestion thrown out by Archdeacon Verschoyle, as to the geological age of the Bundoran strata. Also that, accompanied by Professor Sedgwick, he has had an opportunity of verifying the accuracy of his map in regard to the occurrence of a large hummock of crystalline greenstone at Ballyshannon, one mile east of Carrickbyrne Hill, in the county of Wexford, the existence of which was doubted by Mr. C. W. Hamilton; and lastly, that "having taken a general view of the stratification of the most important localities of the south of Ireland in company with Professor Sedgwick," he "had the pleasure to find he quite agreed as to the accuracy of his (Mr. Griffith's) views of the superposition of the rocks in the several troughs both on the east and west coasts; and, in particular, as to the occurrence of the great fault visible at

Dinas Island at Killarney, and at the Gap of Dunlo, doubted by Mr. Hamilton in his communication to the Phil. Magazine for December, 1839."

To these latter topics I shall not at all advert; several of them were incidentally discussed in my last Address, and as no new facts are adduced, it is not now necessary to return to them. It must, no doubt, be very satisfactory to Mr. Griffith, that his geological views should be sanctioned by the high authority of Professor Sedgwick. But until we have in an accessible form, not merely the opinions of this eminent geologist, but the facts and reasonings on which he founds them, I, for one, must consider these questions still open to doubt, and deserving of further investigation.

But, as respects the question of the true position of the Bundoran strata, it will be proper to make a few remarks. Mr. Griffith having very carefully made a section of the country extending southward between the mica slate of Ballyshannon and the summit of Dartree Mountain, found the successive rocks to be as follows: 1st. The lower limestone. 2nd. Sandstone in a conformable position, and alternating with the shale of the calp subdivision. 3rd. Upper limestone capping the summit of Dartree, and resting on the beds of sandstone and shale, of which the mass of the mountains is composed. From this section, he concludes, and certainly with sufficient reason, that " the sandstone alluded to belongs to the carboniferous and not to the old red sandstone series," this latter view being that put forward by Archdeacon Verschoyle, rather, however, it should be recollected, as a conjecture to be tested by further inquiry, than as a deliberate opinion; assuming, I say, the accuracy of this section, for which the great geological experience of Mr. Griffith is a sufficient guarantee, there can be little doubt of the validity of his conclusion, and none whatever that the arenaceous beds in question do not belong to the old conglomerate.

I am obliged, however to observe, that the section just described by Mr. Griffith, and the colouring of his map in this district, are not in consistency with each other; for the arenaceous beds which he describes as component parts of the calp, or middle limestone, appear to me to be coloured as if they were the yellow sandstone, whose position is much lower in the series, being interposed between the lower limestone and the old red sandstone.

I have now, Gentlemen, submitted to you a summary of our proceedings for the past year, sketched certainly without partiality or prejudice. My object on the present occasion as well as the past has been to present, as far as my slender abilities allowed me, a faithful outline of the communications brought before us, accompanied as little as possible by any comments of my own. I have always, I believe, been sufficiently ready to award the meed of praise, the praise of this society, to those who have earned it by the practical value of their geological labours. I admit I have not dealt in indiscriminate eulogy, for to a course so unsuited to science and its votaries, I avow I entertain an insuperable objection. If any, however, should feel, or have felt offended at anything I have said, or omitted to say, I would remind them in mitigation, that I have always confined myself to a detail of facts, or to such inferences as flowed immediately from the facts, and that I have never indulged in anything approaching to censorious animadversion. Nobody can be more convinced than I have been of my numerous deficiencies, and that the chair of this society might be much more efficiently filled by several gentlement present. My defence, however, if, indeed, any be necessary against an imaginary complaint of my own suggestion, is, that I have always, to the best of my ability, and certainly with the best possible intentions, endeavoured to discharge the onerous and sometimes difficult and invidious duties imposed upon me.

And here, Gentlemen, in vacating the honourable post to

which your kindness has raised me, I wish to observe that it gives me much pleasure to find I shall be succeeded by an individual in every respect so worthy of your choice as him whom you have recently elected. Dr. Scouler will bring with him into office qualifications of a high kind, an extended acquaintaince with the mineral constitution of the strata composing the crust of the earth, a profound knowledge of its fossil organic contents, and, what is even better than both, a talent for minute and accurate observation, and an ardour in the pursuit of those studies which comprehend the varied objects of modern geology. Under his guidance, and with the assistance of those tried friends who, through good report and evil report, have stood by the Geological Society, I anticipate an augmenting prosperity, and that the field of our exertions will be gradually but greatly extended. We are, I think I may say, starting upon a new career, and with brighter prospects, having been relieved from difficulties of a financial nature, which unfortunately clog even the march of science, by our removal to the extensive and commodious apartments in which we are at present assembled. To the eminent individual who lately represented Her Majesty in this country we are, I believe, chiefly indebted for this very timely patronage ; but the intentions of Earl Fortescue would, for reasons into which it is not necessary to enter here, never, I believe, have been carried into effect, were it not for the active interference in our behalf of General Sir John Burgoyne, who presides with such deserved popularity and so much benefit to the country, over the Public Works of Ireland. Sir John saw the great importance of geology, even in relation to the engineering operations with which he is more immediately connected, and did not relax his exertions until he accomplished for us an object which, while it greatly enlarges our accommodations, and secures our sta-

bility, imposes on us at the same time the duty of justifying the liberality of the Executive, by strenuous and united efforts to extend in every possible way our "knowledge of the mineral structure of the earth, but more particularly of Ireland."

THE ANNUAL REPORT

OF

THE COUNCIL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN,

FOR THE YEAR ENDING FEBRUARY 8TH, 1843.

REPORT.

Your Council, in presenting you with the Twelfth Annual Report, have to congratulate the Society upon the state of their finances; and although they are not as yet sufficiently flourishing, to admit of that increase of expenditure which the establishment of a Curatorship, and other most desirable undertakings anticipated in former Reports will involve, yet, they do look forward to the Society's being able soon to increase its sphere of utility.

Since the last Annual Meeting, the collection of rocks and simple minerals has been arranged by Doctor Apjohn and Mr. Renny, and in such a manner as to be fully available to the Student: and cases have been ordered, in which it is proposed to arrange a collection of Irish rocks.

The Museum of the Society has been increased by liberal donations of fossils, from the coal districts of England, by the Earl of Enniskillen, of fossils, from the alum shales of Whitby, by Robert Mallett, Esq., of various fossils from the slates and limestones in the neighbourhood of Cork, by Francis Jennings, Esq. and by a species of Cirrus, described as new, and named Euomphaloides, by Frederick M'Coy, Esq Also by a specimen of carbonised wood, by Mr. Murray.

Your Library has received the Ordinance Maps of the Counties of Kilkenny and Clare, presented by His Excellency the Lord Lieutenant, through Colonel Colby, and the Geological Report of the County of Londonderry, presented by the Master General and Board of Ordinance.

Your President has contributed six papers upon Palæontology, while the only subject to which your Council feel any regret in adverting, is, that only three papers have been read on subjects of descriptive Geology. But the means by which your Society have to excite Members to enter warmly into the collection of the facts upon which all Geological speculation must be based, will form part of your President's Address, and your Council will therefore conclude with presenting to you the Report of your Treasurers.

INCOME AND EXPENDITURE OF THE GEOLOGICAL SOCIETY,

IN THE YEAR ENDING 8TH FEBRUARY, 1843.

DR.	£	*s.*	*d.*
To Payments during the year	88	4	7
To Balance in Treasurer's hands	22	4	1½
	£110	8	8½

CR.	£	*s.*	*d.*
Balance of last year's Acount	0	8	8½
Receipts for the year	110	0	0
	£110	8	8½

WM. EDINGTON,
ACHESON LYSLE, } *Treasurers.*

OFFICERS OF THE SOCIETY,

FOR THE YEAR 1843.

President.

John Scouler, Esq., M. D.

Vice-Presidents.

Richard Griffiths, Esq.
Captain Portlock, R. E.
James Apjohn, Esq., M. D.
Rev. H. Lloyd, D. D.
Robert Ball, Esq.

Treasurers.

William Edington, Esq.
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Secretaries.

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William Murray, Esq.
Thomas Oldham, Esq.
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Thomas Hutton, Esq.

JOURNAL

OF

THE GEOLOGICAL SOCIETY

OF DUBLIN.

XII. *Address delivered at the Twelfth Annual Meeting of the Geological Society, by* JOHN SCOULER, M. D. F. L. S., Professor of Mineralogy to the Royal Dublin Society, and President of the Geological Society.

[8th February, 1843.]

GENTLEMEN.—The duty of addressing you on this the Twelfth Anniversary of our Society now devolves upon me, and I confess I undertake it with feelings of considerable embarrassment, whether I look back to the able addresses delivered by my predecessors in this chair, or to the limited field of observation to which I must confine myself.

In taking a retrospect of the proceedings of the Society during the past year, I am happy to have it in my power to commence with a subject which cannot but afford matter of satisfaction to the Society. One of the most indispensable compliments to an Association like ours is a collection of such objects as we must refer to during all our discussions, or of a Geological Museum of well selected and correctly named specimens. During the past year that department of our collections which includes simple minerals and rock specimens, has been

brought out of the confusion in which it formerly was. The specimens have been named and systematically disposed, so that it is now an available means of instruction for all who choose to consult it to improve their knowledge in this very difficult but important branch of Geology. For this valuable service the Society is indebted to the exertions of my predecessor, Dr. Apjohn, who devoted a considerable portion of his time to the task. I have also to express our thanks to our indefatigable Secretary, Mr. Renny, for the aid he has rendered in taking charge of the Museum, as well as on many other occasions.

In the other department of our Museum devoted to organic fossils, we are still extremely deficient, more especially in that which, of all others, ought to be the most elaborate, namely, the fossil remains from the carboniferous limestone. In the past year, however, some progress has also been made in filling up our deficiencies in consequence of the liberal donations of scientific individuals. The Society is indebted to the Earl of Enniskillen for a very extensive and valuable collection of organic fossils, chiefly from the upper secondary strata which will fill up many blanks in that part of our collection. To Mr. Jennings, of Cork, we have also to express our obligations for repeated donations of fossils from the carboniferous limestone of the South of Ireland. These specimens are particularly acceptable as they are from a district of much geological importance which has already given rise to interesting scientific discussions.

In proceeding to give an analysis of the papers read, or of the subjects discussed before the Society, I am sorry, that in one respect I cannot hold out the language of unmingled congratulation, but must rather regret the deficiency of original communications tending to advance the general progress of the science, or even the details of the physical structure of our own country. The objects of our Society comprehend every thing relating to Geology in the most

extensive sense of that word, while, at the same time, there is one subordinate deportment of the science which ought to be peculiarly our own, I mean the illustration of the physical structure of Ireland. Notwithstanding the comparative simplicity of the mineral, when compared with the organic kingdoms; and although the granite of Brazil may differ but little from those of Greenland; and there may be a close analogy between the Silurian strata of Canada and Russia; still every region of the earth has its geological features, corresponding in some degree to those observed in the vegetable and animal kingdoms, from the laws of distribution of organic bodies. In England the newer secondary formations are displayed as in a model, and this circumstance may be said to have impressed its features on the character of English Geology, as in like manner the abundance of erupted rocks in Scotland may be said to have given a direction to geological research in that country. The structure of Ireland has also its prominent marks in the vast development of the carboniferous limestone, and its associations with the inferior Silurian rocks, and the upper carboniferous strata. In this vast field of inquiry, comprehending so many questions respecting the identification of strata, their succession and classification, and the determination of their organic fossils and comparison with those of distant countries, very little has been accomplished by our labours. On other and more general topics our contributions to the mass of facts and principles has been far from numerous.

If we compare the progress of a taste for geological pursuits with the advance of the other branches of natural history among ourselves and elsewhere, we are struck with some remarkable circumstances by which the selection of such inquiries appears to be guided. With us it is pleasing to observe the increasing success with which botanical and zoological pursuits are followed, while the progress of Geology has been much slower; in England the reverse seams upon

the whole to be the case, and the history of the fossil and mineral kingdoms appears to be followed out with greater zeal. On this subject I cannot omit to mention the suggestion of a very able and zealous member of this Society, that our exertions should, in part, be employed in diffusing a taste for the science, and exciting a greater degree of interest in its favor among intellectual individuals. Adopting the suggestion I think I may venture to hold out a reasonable anticipation that an increased interest will be given to our future Meetings. And while, on all occasions, original matter will take the precedence, in its absence information of importance will be supplied, to which few but professional geologists could otherwise have access.

In proceeding to offer an analysis of the papers which have been read and discussed at our Meetings, the first that I shall notice is one by our Secretary, Mr. Hamilton, on the indications of the former existence of glaciers in the South of Ireland. Mr. Hamilton's observations were made in the neighbourhood of Dingle, and are accompanied by drawings which he made on the spot. He mentions, particularly, two rounded rocks, which, in this respect, form a contrast with the sharp serrated peaks in the vicinity. When the vegetable covering has been removed, the rocks exhibited a polished surface, scratched in one direction, which is that of the descent of the valley. There are some instances where two perpendicular surfaces of rocks are furrowed with deep channels, following the same directions, and presenting the appearance sometimes seen where a chain has worn the edges of a pier. The polished surface was in all cases on the edges of the lamellar of cleavage, and thus, that which at first appears to be the surface of a flag, when struck by the hammer, is found to be an artificial surface produced where not even a joint exists. Mr. Hamilton having satisfied himself that the tendency of these scratches, like that of the valleys was toward the South, was induced to examine the Northern ravines of some of our high mountains.

On ascending the Keeper Mountain in Tipperary, he found the same kind of scratches within a short distance of its summit, in two ravines tending to the North, the scratches having the same direction.

Before making any observations on the glacier theory, I may mention another paper on the same topic, which was read by the President at a subsequent Meeting of the Society. In this communication an account was given of the appearance of the County forming the Valley of the Clyde, especially in the upper part of Lanarkshire, and near the falls. The writer remarked, that on the margins of the river, more particularly below the lowest fall, we can observe successive terraces, or portions of level land, rising above each other, and those on the opposite sides of the stream corresponding in their levels. This appearance is more conspicuous considerably below the lowest fall in the course of the long and deep ravine which the river has excavated in the old red sandstone. Indications of these lines can be seen gradually receding from each other, as the country on both sides of the river expands into a broad valley towards Hamilton. On the South side of the river indications of a long line can be traced on the sides of a low range of hills, extending to the South for more than two miles. On several places on the margins of the river, deep accumulations of transported and irregularly stratified matters were seen, in which, however, no remains of shells were found. The author of the paper was of opinion, that these indications of ancient terraces were merely the evidences of changes of level of the sea, or in other words, proofs of elevation. That they were not to be regarded as lateral moraines, seemed evident, from the stratified arrangement of the loose materials, an appearance which could not be assumed by sand and gravel propelled before a glacier. The explanation of the appearances in the upper part of the Clyde, was that given by Mr. Darwin, in his excellent paper on the parallel roads of Glen Roy. In the present instance this solution of the ques-

tion was demonstrated to be the true one, by collateral evidence, which had not yet been obtained in the case of Glen Roy, for Mr. Smith had found beds of marine shells in the adjacent country, and at levels as high as those of the falls of the Clyde.

With respect to the contents of these two communications, I may remark, that it appears to me that the glacier theory, whether we view it as explaining the carriage of detritus propelled over dry land by means of descending ice, or the floating of masses of rock upon icebergs to lower latitudes, seems to be a *vera causa*, solving many difficulties which would otherwise be insuperable. We find undoubted moraines in countries and positions where the existence of glaciers is impossible under the present meteorological conditions of these regions. As these appearances are unambiguous, we must conclude that they can only be explained by admitting such a change of climate as permitted ice to accumulate both at smaller elevations, and also at lower latitudes than at present, at least in those districts where ancient moraines occur. In this respect, however, the glacier theory does not present any particular difficulties. If, at a former period, a colder climate existed, which can be explained only by the assumption of a change in the configuration of the Northern and temperate parts of Europe, and in a change of the relative distribution of land and water; we know, upon the clearest evidence, that such changes have taken place. The numberless beds of clay and irregularly stratified gravel, containing marine shells of our actual seas, of itself proves such altered configurations of land as to involve very great changes in the isothermal lines, as well as in all those circumstances which constitute the difference between an equable and an extreme climate. When we find, for example, an angular block, transported from some distant country, resting on a bank of stratified shelly gravel, we may be said to have the evidence both of the former submersion of the county, and that the boulder has been floated from a remote source. The absence of transported rocks in tropical

climates, has been noticed by Mr. Darwin, and when this important, although negative fact, is confirmed by more extensive observations, it will afford a strong collateral evidence of the truth of the glacier theory, whose direct proofs can only be drawn from extratropical countries.

In these investigations we must bear in mind, that although, in numerous cases, we can establish, in a satisfactory manner, the existence of moraines in countries whose highest mountains are at present under the line of perpetual congelation; there are other cases in which much caution is required, and the occurrence of beds of detritus on both sides of a valley is not, of itself, an unequivocal proof that they were produced by the descent of a glacier. This appears to me to be remarkably the case in the valleys of the Dublin Mountains, where, in every instance, I have examined, the occurrence of stratification and of marine shells proves that the phenomenon is one of elevation. If we are to explain all such accumulations by the descent of glaciers, how shall we account for the formation of the valley of Coquimbo, situated within a few degrees of the equator?

The next communication which I have to mention is one from Mr. Griffith, entitled a notice of three small detached Silurian districts, which occur in the Counties of Tyrone, Fermanagh, and the East of Mayo. The researches of Mr. Murchison, respecting the Silurian strata of Wales, form one of the most important contributions which have been made, to our knowledge, of stratified rocks. Previous to the publication of his observations, the fossiliferous strata between the old red sandstone and the primary rocks, was, to a great degree, an unknown region, every thing being confounded under the vague denomination of transition strata, a term which, like some generic ones in zoology and botany, served as a recepticle for all that was obscure and uninvestigated. The immense series of rocks which the labours of Mr. Murchison has brought to light, are, however, scarcely inferior in interest to the newer secondary

formations which succeed them, and have greatly increased our field of investigation, and afforded to the zoolagist new forms of organic bodies, and many beautiful modifications of structure. The knowledge we have obtained of the Silurian rocks has served as the point of departure for further investigations, proving the generality of these rocks, which we know to extend over immense districts in Russia and North America. For a knowledge of the Silurian rocks of Ireland, we are indebted to the author of the present communication, and also to Captain Portlock, whose extensive researches we shall have occasion hereafter to notice.

Of the three Silurian districts mentioned by Mr. Griffith, two were discovered in the north of Ireland, and both inferior in position to an extensive tract of sandstone which reaches from Lough Erne, north of Enniskillen, in a north west direction to Coockstown, in the county of Tyrone. The most important of these districts is situated to the east and south of the village of Pomeroy, in the county of Tyrone, and the second surrounds the village of Lisbellan, in the county of Fermanagh.

The Silurian district of Pomeroy is composed of beds of micacious sandstone and clay slate, it rests at least in part upon granite, and is followed by the overlaying sandstone. This district is about three miles in length, and two in breath. It was, says Mr. Griffith, originally considered by me as belonging to the old red series; but previously to the year 1835, Captain Portlock, of the Royal Engineers, discovered in it a great variety of fossils belonging to the silurian series. It abounds in Graptolites, Trilobites, and Orthidæ; but Mr. Griffith has not discovered any of the ordinary corals which are abundant in many other Silurian districts.

The second district (that of Lisbellan) is more obscure in its relations than the proceeding one. Its upper part consists of chloritic quartzose conglomerate alternating with clay slate, and in his geological map is put down, by Mr. Griffith, as a

portion of the old red sandstone. By the aid, however, fo subsequent researches, it was rendered extremely probable that this determination of the Lisbellan rocks was an erroneous one, and that in fact they belonged not to the red sandstone, but to the silurian series. This opinion was further confirmed by the discovery of a Trilobite, Orthoceratites, and Graptolites in the schist, associated with the conglomerate.

The third Silurian district was recently discovered by Mr. Griffith in the county of Mayo, about four miles west of the town of Ballaghdoreen. From the nature of the surrounding rocks and superficial detritus it was difficult to ascertain minutely all the relations of this Silurian formation. The strata consists of alternations of dark gray arenaceous limestone, overlaying gray calcareous slate. These strata are surrounded on every side by rocks composed of metamorphic porphyry and reddish brown sandstone, the relations of which, to the clay slate, have not yet been ascertained. Fortunately, however, the fossils collected by Mr. Griffith throw much light on the history of this district. They differ in a remarkable manner from those of Pomeroy and Lisbellan, and consist almost entirely of Zoophytes; no Trilobites were discovered, and only a few varieties of bivalve shells too imperfect to be easily determined. The Zoophites are the same as those which occur in the Wenlock limestone of Mr. Murchison.

Such is a brief outline of this valuable contribution to the history of the Silurian rocks of Ireland. It appears to me that, notwithstanding, all that has been accomplished in this respect, that we are yet upon the threshold of the subject. The labours of some of the most distinguished members of this Society have been directed to the investigation; and by none with more success than the author of this memoir, and by Captain Portlock in his recent publication. The rocks of this series have been shown, if not occupying wide areas of country, to be very generally diffused. They have been observed in

Tyrone and Kerry, in Mayo, and in the county of Dublin, and are known to be of very different ages from the inferior strata, containing Graptolites up to coralline beds, analagous to those of Wenlock and Dudley. When we consider the great extent of Ireland which is covered by the old red sandstone, carboniferous limestone, and superior rocks, it is not very probable that the Silurian rocks will possess any thing like the decided features, and great geological importance which they display in England. This circumstance while it detracts somewhat from the interest, at the same time adds to the difficulties of the investigation. It is chiefly in the obscure outline between the inferior portions of the old red sandstone, and the subjacent, primary, and metamorphic strata that we can seek for outliers or outcropping portions of Silurian strata. It is with these strata, in some respects, as with the dykes, and protruded masses of erupted rocks where there are so few theoretic rules to guide us in the search for them. At the same time there can be little doubt that those who have already done so much will, from time to time, be able to contribute more.

The next paper I have to notice is one, by Dr. Scouler, on the natural history of the Mastodon giganteum. The subject of this communication was suggested to Dr. Scouler, by the examination of the skeleton which is at present exhibiting in Dublin. Omitting any discussion concerning the Missourium as being what naturalists call a nominal genus, the author of the paper observed, that by the publication of the Ossemens fossiles of Cuvier, when it was demonstrated that the Mastodon was a terrestrial herbivorous Pachyderm, and furnished like the elephant with a proboscis, other interesting questions respecting its history had arisen. The late Dr. Goodman had discovered several lower jaws, possessing the general characters of those of the Mastodon, but distinguished from them by possessing two small but distinct incisive teeth. Convinced that this peculiarity constituted a generic distinc-

tion, Dr. Goodman was induced to believe that the lower jaws, furnished with incisives, belonged to an animal different from the mastodon, to which he gave the application of Tetracaulodon.

The scientific interest of the question therefore turns chiefly upon the discussion of the importance of the presence or absence of the incisive teeth, as constituting a generic or even specific distinction between nearly allied proboscidian animals. In reference to this subject, it is of importance to remark, that if the discovery of Dr. Goodman amounted to a generic distinction, we might have expected that corresponding differences might have been observed in the other bones attributed to the Mastodon. We know that there are osteological differences between the two living and the fossil elephant, besides those derived from the teeth or jaws. On the contrary, I am not aware of any osteological differences between the Mastodon and Tetracaulodon, except the one under dispute. In the present state of our knowledge, therefore, we have only to investigate the value of analogical evidence in respect to the importance of the presence or absence of incisive teeth in the lower jaw of the mastodon. Upon this topic it is to be remarked that even in mammiferous animals in general the incisive teeth appear to be much less importance than the molars in constituting generic distructions, they are oftener absent, and they perform a less important part in the function of mastication. In many of the bats, for example, the incisive teeth fall out at an early period, and which is more immediately related to the present question, the same thing takes place in the Phacochæres a pahydermatous animal. What is still more important, we find in the Narwal the presence or absence of the incisives of the upper jaw constitutes a sexual distinction only. The very irregularity, in this case makes the observation the more satisfactory. In most cases the male has a solitary incisive, while none are apparent in the female. In other instances the male has two

tusks, and sometimes the tusks of the female are developed. Substituting the lower for the upper jaw, this is very much what we observe in the Mastodon. Lower jaws of all ages have been found destitute of incisives, while other series of lower jaws have been observed with small tusks, and what is still more important, jaws have been found with only a single tusk, in analogy with what was noticed in the Narwal. It appears upon the whole, therefore, to be the more probable opinion that the presence or absence of incisives in the lower jaw is a sexual distinction, just as the greater or smaller size of the upper tusks constitutes a sexual distinction in the Asiatic Elephant.

If such be the unfortunately too meagre list of communications which have been read before the Society during the past season, I am happy to add that a most important contribution has been made to the Geology of the Ireland by one of our Members, I mean the report on the Geology of the county of Londonderry, and parts of Tyrone and Fermanagh, by Captain Portlock, and published under the auspices of the Board of Ordnance. I have, however, exceedingly to regret that this most important and elaborate work, containing nearly eight hundred pages of text did not come to hand until less than a week before the anniversary of our Society. I have to state this in justice to the Society and the Author, and as my apology for the deficiency of my analysis, as well as for my errors or misconceptions into which I may fall. It is scarcely necessary to observe that this work comprehends a vast variety of topics extending to almost every department of geological investigation. The district selected for investigation, especially the conterminous county of Antrim, is more rich in varied phenomena of deep geological interest, than the remaining counties of Ireland taken together. Under the head of erupted rocks, from the granite to pearl-stone porphyry, it presents a series of igneous products, more varied than is to be found in any other district of the British Islands. In respect

to the stratified rocks it presents a nearly uninterrupted series from the primary strata to the chalk, thus constituting an epitome of the structure of the globe. The simple minerals and organic fossils are of corresponding importance, either as respects variety or scientific interest. On all these topics much important information is to be found in Captain Portlock's work which abounds in minute accuracy of description, combined with a systematic arrangement of materials which cannot fail to render it particularly valuable to those who wish to explore the district he has described. Besides the descriptive matter of the work, it contains a detailed geological map, and a very numerous collection of sections, and forty-three plates, representing new or little known organic fossils.

In one of his introductory chapters, Captain Portlock gives a very careful and accurate account of the labours of his predecessors, in this field of inquiry, exhibiting very extensive research, and in which the labours of his predecessors are stated with much detail and candour.

Under the difficuty which I feel from the very superficial attention which I have been able to bestow upon so extensive a work with so little time for a careful perusal of its contents, I must restrict myself to a few very brief remarks. The basaltic rocks of the North of Ireland have been famed for the rich variety of amygdaloidal minerals which they afford to the collector. Captain Portlock has devoted a chapter of his work to the investigation of the simple minerals of this district, and his catalogue suggests many important topics for reflection to the chemical geologist. If we compare the amygdaloidal or zeolitic minerals of the North of Ireland, with those of the trappean country of the West of Scotland, we observe some curious points both of analogy and contrast. Certain minerals are common to both districts, but, at the same time,

exhibit such modifications of crystaline form and degree of transparency, that an experienced minerologist can readily ascertain by mere inspection the country from which any given specimen has come. Thus the Analcimes of Ireland are always transparent, while those from Scotland are as uniformly opaque. If we extend our comparison, we find that species of frequent occurrence in the one district are rare, or altogether absent, in the other. Thus Hydrolite, which is common in Ireland, is very rarely found in Scotland, and conversely Harmotome, Thomsonite, and Prehnite, are all but absent from the amygdaloidal minerals of the Irish traps. We have thus an illustration of the variation of the same laws under varieties of local modifications which give to the productions of the mineral kingdoms something of that variety which we observe in the organic kingdoms, from disposition into distinct geographycal regions.

If we were to enter into discussions respecting the causes of this diversity, it might be interesting to inquire whether it resulted, at least in part, from the difference of mineral composition, especially in the felspathic ingredients of erupted rocks; at least this is certain, that while potass felspar (Or those) predominates in the Irish traps, Labradorite is more common in those of Scotland. As the greater number of these amygdaloidal minerals consist of silicates of potass, soda, or lime, with water, in a state of chemical combination, we may perhaps regard them as hydrated Felspars, in which the quantitative proportions of the Felspar have been changed. This view of the matter is rendered the more probable from the absence of all ferruginous zeolites, iron exists in all trappean rocks, either as a constituent of Pyroxene, or disseminated in the state of oxide, but the insolubility of its salts in the state of peroxide, appears to have prevented the formation of a series of ferruginous hydrated silicates. These views which

we have ventured to put forward, may have some interest, inasmuch as they tend to connect the history of simple minerals with the theories of geology relating to volcanic action.

Perhaps the part of the work richest in new matter, is that devoted to the history and description of organic fossils. In this department there was much scope for discovery; no monographs of Irish fossils had previously been published. The table published by Mr. Griffith and Mr. M'Coy, was limited to the fossils of the carboniferous limestone, but we had no minute information respecting the remains found in the chalk and lias of the North of Ireland, or of the Silurian rocks. The publication of Captain Portlock affords us much information in this hitherto but little explored department, of which I will endeavour to give a very brief notice. When we institute a comparison between the fossil remains of invertebral animals of the different secondary strata, we find a very remarkable difference in zoological character between the remains found above and those found below the new red sandstone. In the lower strata we find entire genera which do not reappear in the upper secondary formations. The extensive family of Trilobites, the Leptaenæ Spirifers and Orthoceratites characterise the older formations, extending through the whole of the silurian and carboniferous series. In the newer secondary rocks these fossils are absent, and we find instead of Trilobites the remains of decapode crustaceæ, new forms of chambered shells, such as Ammonites, Belemnites, Turrilites, and Bacculites, are substituted for the older forms of nautiloid shells. Of these various tribes of extinct fossils the Trilobites may, especially, be considered from many interesting points of view. In their zoological characters they stand alone in the class of crustaceæ, possessing many organs similar to what we observe in a recent crustaceæ; but the union of these analogies in the

same animal exhibits an association of structure of which we have no living example. In their geological distribution their history is equally remarkable, they have existed throughout that immense epoch which has elapsed from the deposition of the earliest Silurian stratum, up to the new red sandstone. In a practical view their discrimination is of great importance, since particular species, perhaps, even genera, are characteristic of geological epochs.

The study of the Trilobites like that of the formations in which they are found is of recent date. M. Brongniart's work, which is the first systematic treatise on the subject, was published in 1822, is, in fact, our point of departure in that inquiry. In this treatise the author describes only twenty species which he distributes under five genera which he constructed for their reception. Since the publication of M. Brongniart's work, our knowledge of the Tribolites has been greatly increased, especially by the labours of the Swedish and North American Geologists, and subsequently by the researches of Mr. Murchison contained in his beautiful work on the Silurian rocks. Such has been the progress of this branch of fossil zoology, that we now know more genera than Brongniart did species, when he published his work, and the number of species has been increased in an equally remarkable degree. Captain Portlock, in his voluminous report, has added very considerably to the amount of our previous knowledge, we have thirty new species, most of them well characterised and illustrated by numerous figures, and the three new genera constituted under the appellations of Phillispia, Griffithides, and Remopleurides.

I am sorry that, for the reason already stated, I cannot enter into similar details respecting the other contributions to palæontology which are to be found in this work, especially with respect to the cephalopode shells, concerning which

much information is given, which will be new to the Irish Geologist.

Before quitting this topic I am desirous to notice a very interesting discovery, incidentally mentioned in the Report, that of the tusk of a Hippopotamus found in gravel, near Carrickfergus, by Mr. David Moore, when Botanist to the Geological department of the Survey. This circumstance, is one of more importance than might at first appear, especially to the English Geologist. It is very remarkable that the remains of the larger extinct mammifers which are of comparatively frequent occurrence every where over England and the Continent, should be so very rare in Ireland. Excepting the remains of the Irish Elk, I am aware of only two instances in which the remains of extinct mammifers have been found in this country. I allude to the teeth of the Asiatic Elephant found by Moulyneux, near Belturbet, and the rib of that animal found by Smith, in the county of Waterford. It is therefore important to know that the remains of the Hippopotamus have also been found. This rarety of the bones of so great an animal as the Elephant can scarcely be attributed to negligence, for the tusks, molars, and great bones of the extremeties could not fail to attract the notice of the most incurious. It is also deserving of notice in connection with this subject that the limestone caverns and fissures of Ireland have, in no instance, hitherto afforded a single characteristic bone or tooth belonging to the extinct carnivoræ, no remains of the fossil bear or hyæna have hitherto been observed. It would seem as if even, up to the pliocene period the physical conditions of climate were in some degree different from those prevailing over the rest of Europe, or at all events that there has been some peculiarity in the geographical range of terrestrial animals similar to what still exists. We know that Fauna of

Ireland exhibits many deficiencies when compared with that of England. We have no evidence that the bear, the roe-buck, or the beaver, were ever natives of this country, and at the present day the absence of so many reptiles, and also several insectivorous mammiferæ, as the mole for example, form very interesting subjects of inquiry.

In reflecting on the very important contributions which have been gained to the Geology of Ireland, and still more on the vast progress which the science has made within the present generation, we cannot but be struck with the obvious, although sometimes neglected lesson, that the state of the science can only be estimated by the number of well observed and cautiously generalised facts which it has collected. From the very nature of the questions it attempts to solve, it is obvious that geology could make but little progress, or rather was unable to advance anything like correct or even probable theories, until the different branches of physical science had advanced so far toward maturity as to have ascertained many of the laws of natural phenomena. Geology is eminently a complex, not an abstract, science, and the difficulties it has to solve are often the results of the combined operation of numerous physical laws; it was therefore necessary that these laws should previously be understood, or in other words, that the theory of gravitation should have been established, the doctrine of chemical affinities understood, and the still more abstruse conditions of vital actions had been investigated. In many of the most ordinary instances of geological phenomena, we find that we have to trace this history through an intricate series of the most heterogenious causes. If, for example, we investigate the origin of a piece of crystaline limestone, containing garnets, and extracted from the proximity of some erupted rock, we can look back to the time when the calcarious matter existed in solution in the waters of the ocean, separated

by vital action to form the protecting body of a Mollusc or a Zoophyte; its organic structure changed into a crystalline one under geometrical laws, and new compounds formed from the sileceo ferragenous particles diffused through its substance. In short, a series of changes, in which we must separately consider the vital actions of sentient beings, on the one hand, and those of moleclar combinations and crystallization on the other.

If we take a more comprehensive view of geological inquiries, we find that it only by the constant reference to the principles of other sciences, that we can either make progress in the right direction, or avoid errors. This reference to the physical sciences has finally excluded from geological speculation to many hypothesis of the older speculators. No one, in the present state, will now seek for the origin of our globe on the notions of Buffon, of a fragment detached from the sun by the concussion of a comet; nor will chemistry permit us to believe with Werner in the illimited solvent power of the ocean, and few palæontologists will admit the endless mutations of animals with De Maillet and La Marck; on the contrary, every step gained by the chemist or physiologist, is so far a contribution to geology, and it is to them that we must look for aid in the solution of difficulties, otherwise insuperable, and researches concerning electric magnetism may yet afford the basis of a theory of volcanic action, or of the origin of metalliferous veins.

The various phenomena of geology may be classified under two great divisions, the changes which have happened in the inorganic world, or the influence of gravitation and chemical agents in producing incessant changes in the earth's crust, and in the disposition of its parts, as consisting of land, water, and atmosphere. In this department or mineral geology, we have the incessant and steady influence of gra-

vitation in transporting the desentigrated portions of the rocks to the ocean, to be changed into new strata, and the antagonist influence of chemical powers in solidifying and raising new strata; and we have also the intermediate condition in which the decomposed rocks and transported alluvium affords conditions favourable to the display of vital actions.

Parallel with the long series of chemical changes, we find another series of mutations which have influenced organic bodies; and that while they so far from being excepted from change, have become extinct, while animals and plants previously inexistent, have been called to take the place of the old races. This wonderful series of revolutions in the organic world, is unquestionably the most difficult in the whole compass of the science. That the physical conditions compatible with the existence of living bodies, has been always restricted within narrow limits, appears to be extremely probable. The most ancient remains of vertebral and invertebral animals, do not differ more from the present races, than the animals of the present time differ from each other. The remains of coniferous woods in carboniferous strata, and the occurrence of Molluscs of still existing genera in the lowest fossiliferous strata, are presumptions in favor of the similarity of physical conditions. These physical conditions, however, are liable to fluctuations, as is proved by the remains of every extinct species, no less than when the filling up of a lake destroys the habitat of many species at the present day.

As it is obvious that the history of geological changes must become more obscure in proportion as we ascend to the more ancient formations, and we can only explain the past by the present; hence, the vast importance of studying actual phenomena, and thus obtaining that supply of data so necessary, where we can only employ analogical reasoning, and it is one of the many debts which the science owes to the

distinguished author of the Principles of Geology, tha the has directed public attention to this subject. In bringing these observations to a close, I may only remark, that in a field so varied and extensive, there is surely diversity enough of subjects to please every scientific taste, as well as to occupy all the attention of the most generalizing mind, and notwithstanding all that has been done, Ireland still affords abundance of matter for original research; and let me express my hope that some such fruits of geological zeal will continue to afford increased instruction at our evening Meetings, and enrich the pages of our Journal, and promote friendly intercourse among these engaged in kindred pursuits.